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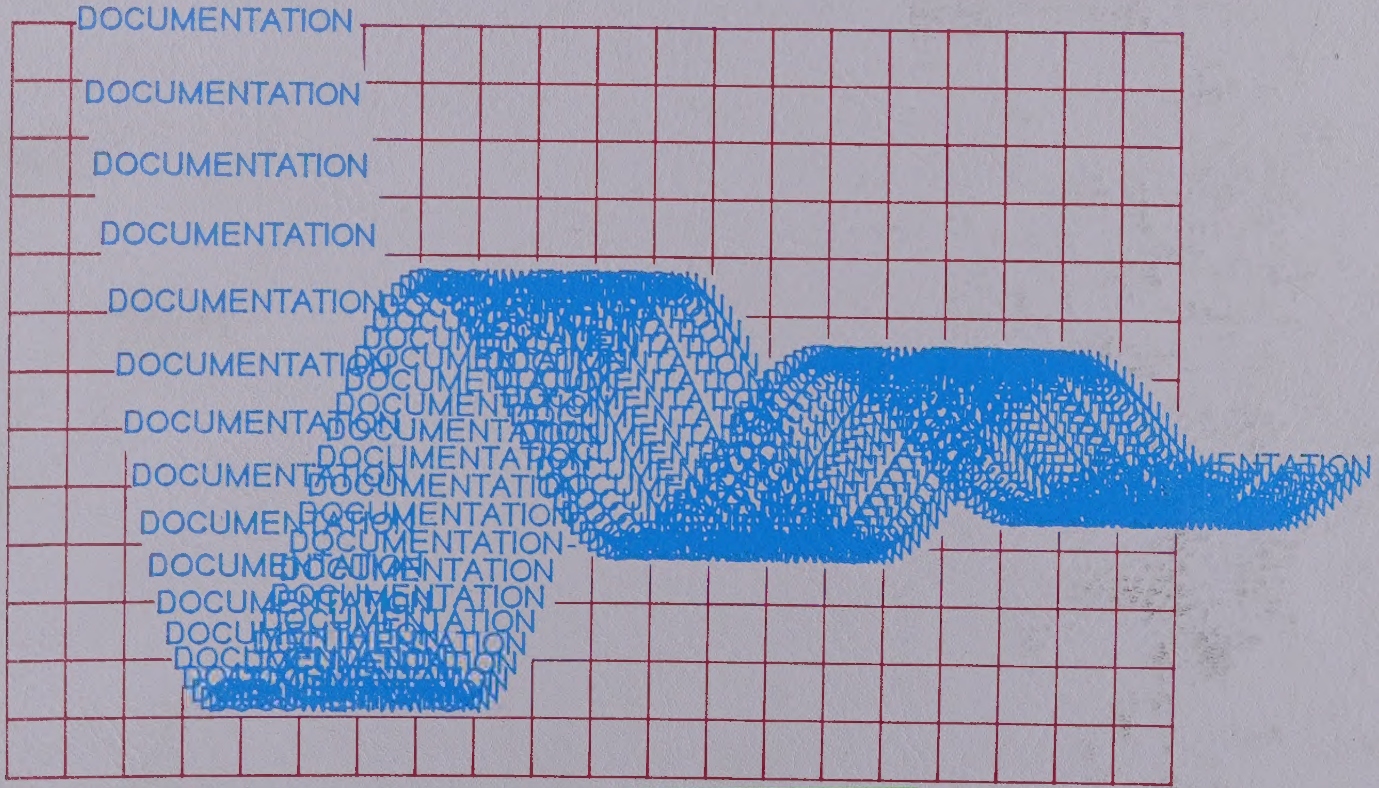


MP MASTER
MA20543

ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

Universal Radio Communication Tester

CMU200/CMU300

1100.0008.02/1100.0008.03

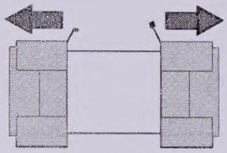
Printed in the Federal
Republic of Germany

CMU200/CMU300 – Equipment Supplied

The CMU is delivered with the following items:

- Universal Radio Communication Tester CMU200/CMU300.
- An AC power cable.
- The following documentation:
  - The present operating manual for CMU200/CMU300.
  - Service manual instrument.
  - Operating manuals for software options purchased with the CMU. All available software manuals are listed before tabbed divider no. 1 of this manual. For a list of options available refer to the data sheet.

Instructions for Unpacking the Instrument



remove protective cabs

- ➢ Take the instrument out of the shipping box and check whether the items listed in the packing list above are all included.
- ➢ Remove the two protective caps from the front and rear of the CMU and carefully check the instrument for damage.

Should the instrument be damaged, immediately notify the forwarder who shipped the instrument to you and keep the box and packing material.

Please observe all safety instructions given in this manual and follow the directions in chapter 1 to put the instrument into operation.

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Data Sheet

Safety Instructions
Certificate of Quality
EU Certificate of Conformity
List of R&S Representatives

Manuals for Universal Radio Communication Tester CMU

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WCDMA
cdma2000
Bluetooth
CDMA
Analog
TDMA
GSM
IS136800 Power

Universal Radio Communication Tester CMU200

THE tester for current and future mobile radio networks

- Multi-protocol support
- Extremely high speed testing
- Highly accurate measurements
- Modular future-proof design
- Comprehensive spectrum analyzer
- Easy migration to 3rd generation technologies

ROHDE&SCHWARZ

Prepared for the 3rd generation

For more than 60 years Rohde&Schwarz has always been at the forefront of mobile radio technology. We continue this tradition of RF test and measurement with Universal Radio Communication Tester CMU 200. The CMU 200 is a third generation platform design, that offers true scalable multimode functionality.

CMU 200 reflects the long-standing expertise Rohde&Schwarz has gained in the world of mobile radio. In recent years, the company has helped to launch overwhelmingly successful mobile radio systems.

Rohde&Schwarz is a preferred supplier to many of the leading mobile equipment manufacturers and is the market leader for mobile radio test sets.

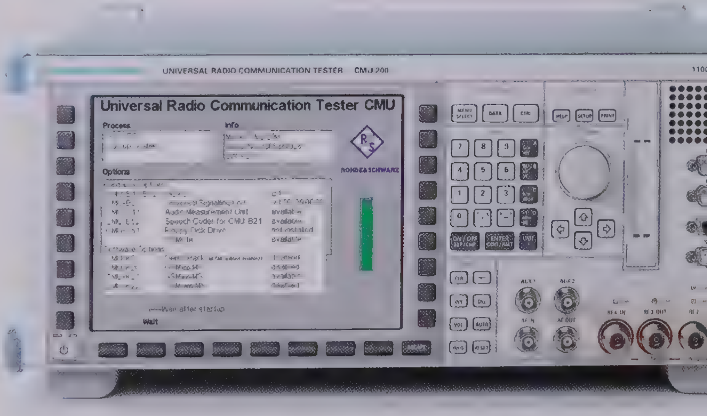
The CMU 200 is part of a complete range of mobile radio test equipment, encompassing everything from conformance test systems, to system simulators, turnkey functional board test / final test systems and simple sales counter Go/NoGo testers.

The base unit with its standard-independent module test provides many general purpose measurement facilities for the development of all kinds of standards within its wide and continuous frequency range. If extended by the relevant options, the CMU200 offers the hardware and software necessary to handle your 3G, "2.5G" and previous generation testing applications including analog.

Low cost of ownership

Selecting the CMU 200 is a decision for the future and results in a total cost of ownership which is sure to be among the lowest due to the following factors:

- Completely modular design of hardware and software components avoids unnecessary high investments right from the start just because there is a possibility of a feature being needed sometime in the future. You only pay for what you need
- Should an extension become necessary because your needs widen after some time – the modularity of the CMU 200 concept will cater for that. Many extensions to the unit may be installed onsite. You only pay for it when you need it
- The concept allows two complete channels (RF, signalling and evaluation) to be installed in one CMU 200 unit
- Maximum production output in a compact 4-rackunit-height package with minimum power dissipation provides compact production space layout
- With the CMU 200 user interface even less experienced users to intuitively get it right without the need for weeks of training
- A new remote interface syntax reflects the inherent modularity of this multimode tester


UNIVERSAL RADIO COMMUNICATION TESTER CMU 200
Universal Radio Communication Tester CMU
ROHDE&SCHWARZ

The CMU 200 targets a wide range of applications, but is primarily optimized for the high accuracy and speed
in an ever more quality-conscious manufacturing process. Shown here, the frontpanel for desktop use.

Applications

- RF development
- Module design
- Module test in production
- Adjustment of mobiles
- Final test in production
- Functional test
- Feature test
- High-end service
- Quality inspections
- Basis for test systems
- Base station simulation

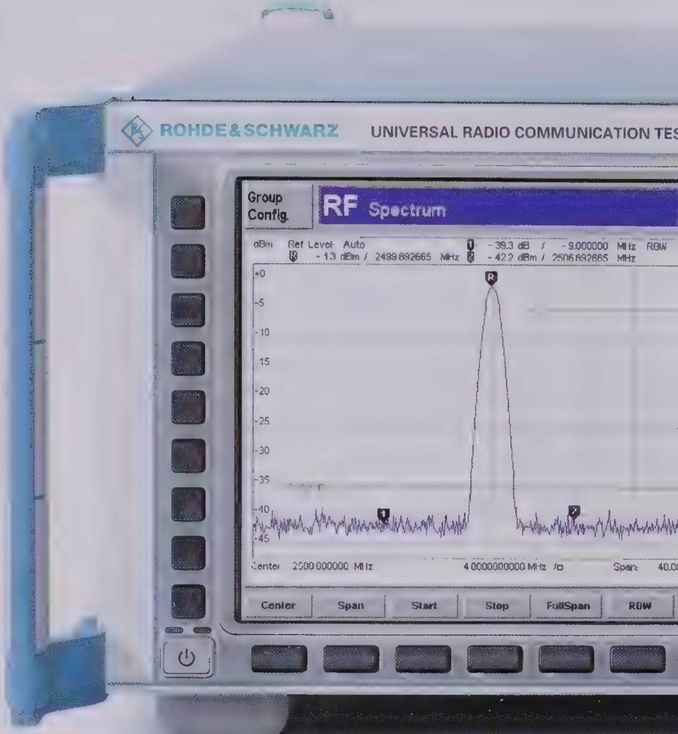
Usability

The CMU200 key strengths

The Radio Communication Tester CMU 200 brings premium cost effectiveness through a variety of features, with extremely fast measurement speed and very high accuracy being the two most important ones. In addition, the secondary remote addressing of the unit's modular architecture makes for intelligent and autonomous processing of complete measurement tasks and fast control program design.

Greatest accuracy

In a production environment the unit's high accuracy allows DUTs (Device under Test) to be trimmed for maximum battery lifetime without compromising quality. In the lab, CMU 200 enables the development engineer to replace conventional, dedicated premium-quality instruments more often than any other radio communication tester and save desktop space at the same time. High precision measurement correction over the whole frequency and dynamic range as well as compensation for temperature effects in real time are critical factors for achieving the CMU 200's excellent accuracy.
The new, globally standardized Rohde & Schwarz calibration system can check CMU 200 accuracy in a service center close to you or, volume permitting, on your site. A world-wide network of these standardized automatic calibration systems has been implemented in our service centers. Highly accurate and repeatable calibration can be performed wherever you are. Your local Rohde & Schwarz representative offers customized service contracts for the unit. For large scale users of CMU 200 a compact level verification system is available, in addition.



Greatest speed

The high processing speed is due to extensive use of ProbeDSP™ technology, parallel measurements and innovative remote command processing. These three aspects of the performance of CMU 200 are explained in more detail below.

- ProbeDSP™ technology
  The modular architecture relies on decentralized ProbeDSP™ processing coordinated by a powerful central processor. Like an oscilloscope probe, DSPs dedicated to a specific local data acquisition and evaluation workload help to keep subsystem performance at an uncompromising maximum even if additional modules are fitted to the CMU 200 mainframe.
- Parallel measurements
  Several RX and TX measurements can be performed in parallel. This is achieved by the fast response of the CMU 200's modular hardware as well as the high overall processing power of the unit and the avoidance of bottlenecks by dedicated operation of the ProbeDSP™ technology employed. Examples of parallel operation are measurements of BER and simultaneous Phase/Frequency error, EVM, Magnitude Error and audio or the various spectrum measurements.

- Innovative remote processing
  The novel secondary addressing mode can address similar functions of each of the CMU 200 subsystems (different mobile radio standard) in an almost identical way. Using this type of addressing, new remote test sequences can be programmed by a simple cut and paste operation followed by editing specific commands to adapt the control program to the new application. Secondary addressing is fully SCPI-compliant which means that a subsystem address, for example "GSM1800", can be replaced by a string denoting a different subsystem, another mobile radio standard.

Greatest reliability

The keys to the high reliability of the CMU200 are the low power intake and the innovative cooling concept. Less power means less heat: Power consumption is way below 200 W due to specially selected low power components, the minimum component count as a concept, plus low voltage design wherever possible.

CMU 200 employs an ultra effective heat management between housings and individual components as well as between heat sinks and the air flow. Independent cooling cycles for the front module controller, the power supply unit and the RF front-end add up to an optimized cooling system.

Key advantages of the CMU200

Speed

- Single measurement up to 10 times faster than the previous generation of instruments

Accuracy

- Three times more accurate than the previous generation of instruments with excellent repeatability

Modularity

- Modular hardware and software concept provides easy extension to further functionality

Bullet-proof

- Low component count, low power consumption, and effective heat conduction result in unparalleled reliability

Future-proof

- Easy migration to future standards

The base unit

As the CMU 200 has a modular architecture, the base unit comes without any network- or standard-specific hardware and software.

The base unit without any options installed can be used for testing general parameters of 1st, 2nd or 3rd generation mobile phones. The CMU 200 base unit is the ideal solution for tasks at module level, i.e. at the early production stages of all cellular standards.

Constituent parts of the CMU 200 base unit are the RF generator (100 kHz to 2.7 GHz) and RF analyzer which are complemented by a versatile network-independent time domain menu and a comprehensive spectrum analyzer. A power versus time measurement is shown on the right. The bright TFT display reproduced here shows the results of the built-in analyzer for the transient RF level of a TDMA phone´s active timeslot in power versus time (zero span) mode.

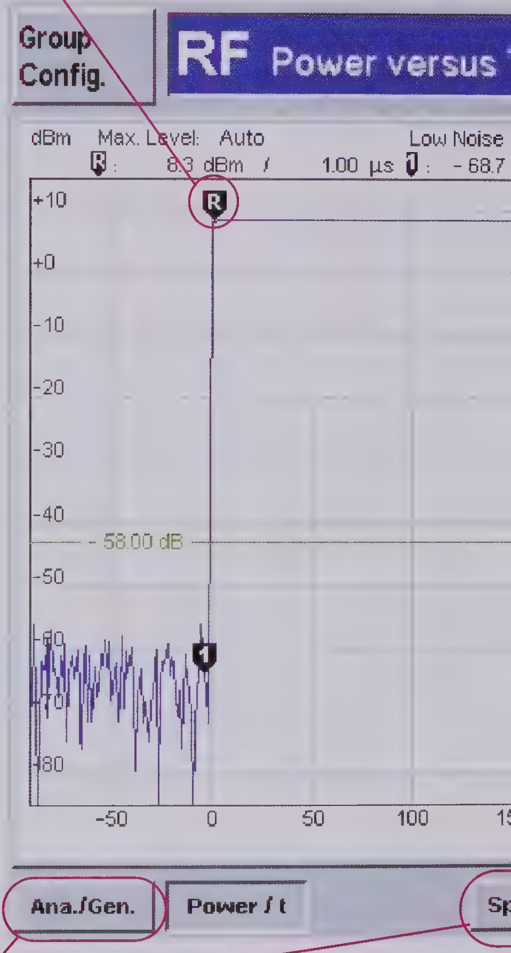
By combining graphical and numerical overview menus the optimal display can be chosen when the CMU200 is in manual mode.

The hierarchical menu structures used in conventional radio testers have been replaced by context-sensitive selection, entry and configuration pop-up menus.

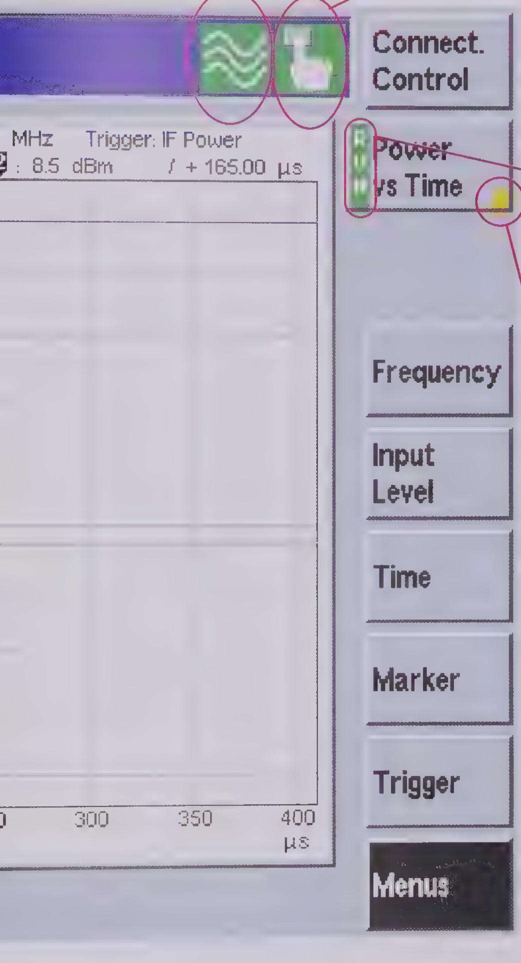
Advanced operational ergonomics have been incorporated into a most compact and lightweight package. Even with the rackmount kit, the CMU 200 height does not exceed 4 rack units.

The rear-panel reference input and output can be used used to synchronize multiple units. It comes fitted as standard.

Thanks to the high resolution of the extremely bright high-contrast TFT display even the finest details can be displayed



Direct branching to all associated menus makes for a uniquely flat menu structure



As the CMU 200 offers many of its measurements in signalling and non-signalling mode, this easy visual indication of the signalling state is provided as part of the status line

This symbol shows the instrument status, i.e. remote or manual operation

For increased speed, not required measurements can be switched off to free resources for the measurements you want to focus on

Measurements are configured by pressing the softkey marked with the yellow triangle two times

Prepared for tomorrow's networks

- Flexible input/output structure
- Platform with multimode modular design
- Wide frequency range from 10 MHz to 2.7 GHz suitable for all mobile radio standards
- Simple operation either manual or via IEC/IEEE bus
- Very high speed
- Simultaneous RX/TX measurements
- Time domain analyzer built in
- Bright high-resolution TFT colour display
- Testing of 1st, 2nd and 3rd generation mobile radio possible in a single unit
- Standard-specific software packages available for tests in accordance with present and future standards
- Network-independent non-signalling test for the development of new or existing standards
- Unrivalled repeatability
- Realtime automatic temperature correction for best accuracy
- Low power consumption
- Low heat dissipation
- Optimized cooling concept for higher reliability and decreased production down time
- Worldwide service network
- Standardized calibration system for the instrument
- Compact level verification test system available
- Universal spectrum analyzer
- Easy 19" rackmounting
- Compact box of only 4 rack units height with award-winning industrial design

TEST MEASUREMENT WORLD
BEST IN TEST
1999
HONORABLE MENTION

DESIGN
AWARD
WINNER
1998
INDUSTRIE FORUM
DESIGN HANNOVER

Optimized solutions for your production test requirements

Rohde&Schwarz supports CMU200 based production test solutions through a comprehensive net of application engineering sites. The backbone to this network is the four system integration centers located in Asia, North America and Europe.

System Integration Services

Regional center project teams offer local system integration, service and support. A team of experts is ready to provide turnkey solutions including test case programming. Custom-tailored project solutions and site process optimization are major aspects of our services. For fully automated production environments we offer inline solutions together with our partners in the field of automation. As an example a fully automated final test fixture including RF test, audio test, keypad test and optical inspection is shown on the picture.

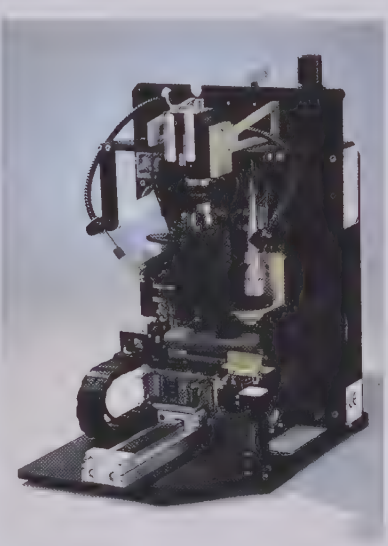
Time to Market

The key to commercial success resides in the time required to get a new product to market in large volume. The crucial point is the fast transition from product development stage to mass production. The TS7100 Cellular Phone Production Test Platform featuring the CMU200 meets this challenge.

TS7100 Description in Brief

The stringent requirements in the production environment of mobile phones make it necessary to implement new strategies in the specification of test systems. The test system architecture is based on two CMD Radio Communication Testers or CMU200s to provide the optimum throughput solution.

The TSVP (Test System Versatile Platform) test platform is based on the industry standard Compact PCI/PXI. This new type of bus is up to 6 times faster than previous industry bus standards. The TSVP's CompactPCI frame is 100% compatible to the industry standard but features 21 up to 31 slots. It comprises a state-of-the-art controller PC, digital multimeter and selectable switching and test modules. For each DUT the test hardware for switching and stimulus functions is implemented as a dedicated set of modules.

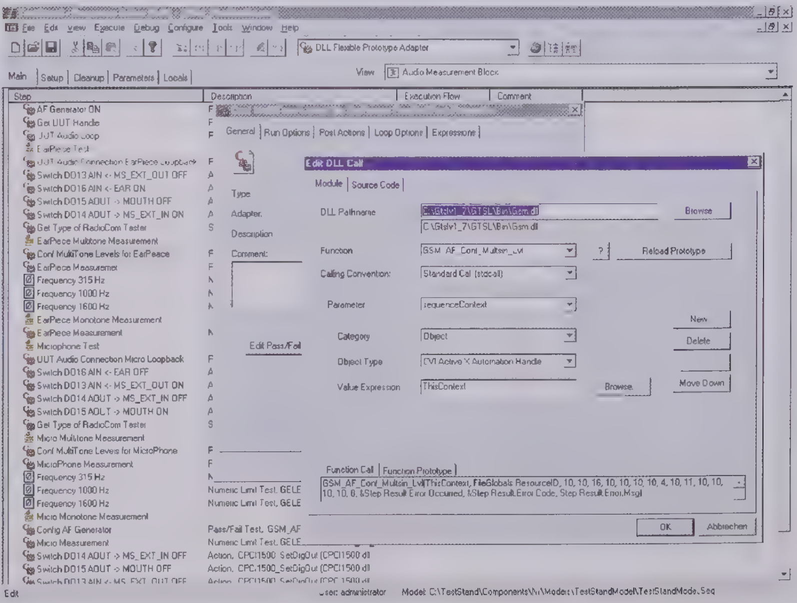


The TSVP takes up all modules used for control and additional measurements.

Off-the-shelf CompactPCI/PXI modules can be added. Up to 4 sets of modules for testing DUTs can be inserted. The software can thus simultaneously use the resources of the parallel instrumentation to maximize speed in highly automated production. We can offer optimal configured test systems customized to your production environment.

Test Executive & Generic Test Software Library Features

The parallel hardware is fully supported by TestStand, the industry-wide test executive from National Instruments. A user-friendly connection to the available device drivers has been created to provide faster use of the test executive. This connection is established by the Generic Test Software Library (GTSL). At the same time the toolkit concept provides ready-to-run test cases, which can be customized by the user as required.



AF Generator ON F
Get UUT Handle F
UUT Audio Loop F
EarPiece Test
UUT Audio Connection EarPiece Loopback F
Switch DO13 AIN <- MS_EXT_OUT OFF A
Switch DO16 AIN <- EAR ON A
Switch DO15 AOUT -> MOUTH OFF A
Switch DO14 AOUT -> MS_EXT_IN ON A
Get Type of RadioCom Tester S
EarPiece Multitone Measurement
Conf MultiTone Levels for EarPeace F
EarPiece Measuremet F
Frequency 315 Hz N
Frequency 1000 Hz N
Frequency 1600 Hz N
EarPiece Monotone Measurement
EarPiece Measurement N
Microphone Test
UUT Audio Connection Micro Loopback F
Switch DO16 AIN <- EAR OFF A
Switch DO13 AIN <- MS_EXT_OUT ON A
Switch DO14 AOUT -> MS_EXT_IN OFF A
Switch DO15 AOUT -> MOUTH ON A
Get Type of RadioCom Tester S
Micro Multitone Measurement
Conf MultiTone Levels for MicroPhone F
MicroPhone Measurement F
Frequency 315 Hz N
Frequency 1000 Hz Numeric Limit Test, GELE
Frequency 1600 Hz Numeric Limit Test, GELE
Micro Monotone Measurement
Config AF Generator Pass/Fail Test, GSM_AF
Micro Measurement Numeric Limit Test, GELE
Switch DO14 AOUT -> MS_EXT_IN OFF Action, CPCI1500 SetDigOut (CPCI1500 dll
Switch DO15 AOUT -> MOUTH OFF Action, CPC.1500_SetDigOut (CPCI1500 dll

DLL Pathname: C:\Gtslv1_7\GTSL\Bin\Gsm.dll
C:\Gtslv1_7\GTSL\Bin\Gsm.dll
Function: GSM_AF_Conf_Multsin_Lvl
Calling Convention: Standard Call (stdcall)
Parameter: sequenceContext
Category: Object
Object Type: CVI ActiveX Automation Handle
Value Expression: ThisContext

GSM_AF_Conf_Multsin_Lvl(ThisContext, FileGlobals.ResourceID, 10, 10, 16, 10, 10, 10, 10, 4, 10, 11, 10, 10, 10, 10, 0, &Step.Result.Error.Occurred, &Step.Result.Error.Code, Step.Result.Error.Msg)

User: administrator Model: C:\TestStand\Components\NI\Models\TestStandModel\TestStandMode.Seq

GTSL

TS7100
Example of a 2-channel ultra-low-profile configuration. PSU and switch matrix fitted to the rear of rack

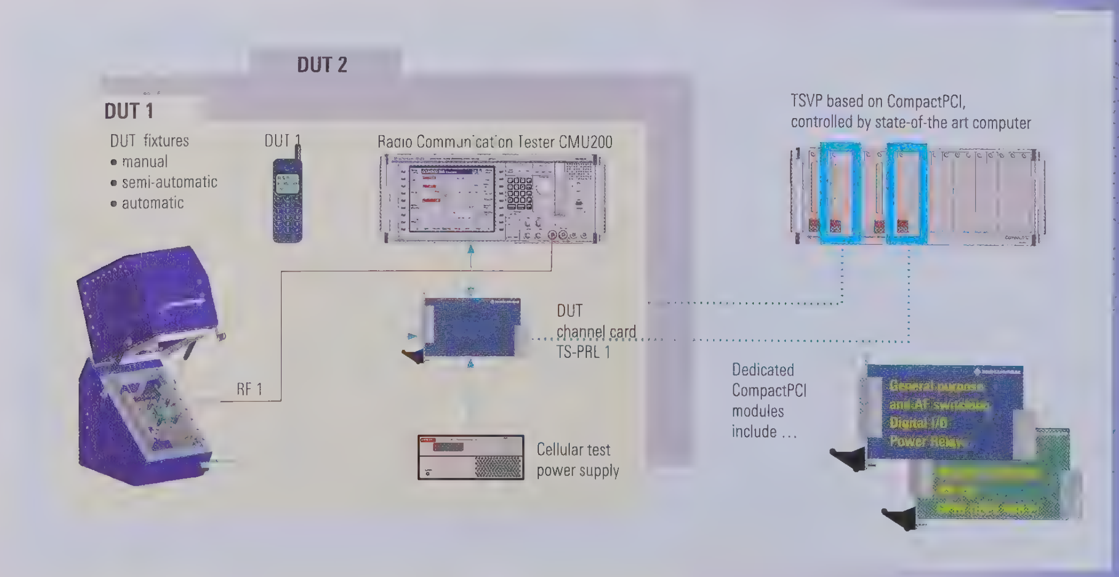
TS7100 Features [illegible]

- High throughput by parallel testing of cellular phones
- All hardware and software components based on industrial standards
- System controller based on CompactPCI/PXI bus arcitecture
- One system for functional board test, phone calibration and final test
- One system for all major cellular phone standards
- Easy expansion to 3rd generation technologies
- Ready-to-run Rohde & Schwarz test library for immediate use or customization
- Provides modular and versatile hardware/software platform
- Reduced costs due to generic concept

For more detailed information see separate data sheet TS7100 (PD 757.5737)

Software concept in brief

- Software platform based on LabWindows/CVI and TestStand from National Instruments
- GTSL includes ready-to-run test cases for the standards supported by CMU200
- Functional test sequences for RF test, calibration, signalling test and audio and acoustic test of mobile phones are supported
- Transparent and open library can be extended by the user
- Operator interface and test cases can be easily customized
- Parallel test of multiple cellular phones is fully supported
- GTSL supports multi-threading and instrument sharing if needed
- Test development time is reduced by as much as 80 %


DUT 2
DUT 1
DUT fixtures
• manual
• semi-automatic
• automatic
DUT 1
Radio Communication Tester CMU200
RF 1
DUT channel card TS-PRL 1
Cellular test power supply
TSVP based on CompactPCI, controlled by state-of-the art computer
Dedicated CompactPCI modules include ...
General purpose and AF switching
Digital I/O
Power Relay

Blockdiagram for a 2-channel configuration of TS7100

Ready for today's networks ...

GSM today

Since its introduction in the early nineties, the GSM system has won acceptance and undergone an evolution that no one could have foreseen.

The applications of the GSM system are numerous and are currently:

- GSM400
- GSM850
- GSM900 including
  - P-GSM (primary GSM)
  - E-GSM (extended GSM)
  - R-GSM (railway GSM)
- GSM1800 (DCS)
- GSM1900 (PCS)

Whether the application is in production, service or development, the flexible concept of the CMU 200 from basic RF signal generation, frequency, power and spectrum analyzer measurements for alignment of modules in production or development applications, to an instrument with full GSM-specific signalling in any of the above-mentioned bands, as well as module tests on frequencies anywhere in the range from 10 MHz to 2700 MHz.

Signalling mode

The options required to support GSM signalling are based on the versatile signalling unit CMU-B21 and one or more of the software options CMU-K20, -K21, -K22, -K23 and -K24. The CMU 200 simulates a GSM base station RF interface with the signalling flexibility necessary to test the behaviour of the mobile under the influence of different signalling parameters. These parameters are normally set by the network operator but can be reproduced by the CMU 200 for test purposes. The unit supports the latest fast location update and direct paging features.

Reduced signalling synchronized mode

The CMU 200 provides the same functionality as in the Signalling mode, but discards any signalling reaction from the mobile connected. This mode of operation enables both testing of modules that only have layer 1 operation and very fast RF testing in production environments. It can also skip the location update procedure in order to save time.

Non-signalling mode

This mode serves for generating a signal with GSM-specific midambles and modulation in the entire frequency range from 10 MHz to 2.7 GHz. The analyzer offers the same flexibility for GSM-specific measurements such as

- modulation analysis
- average and peak burst power
- power versus time, power versus slot, power versus frame
- spectrum due to switching /modulation

GSM development

As an all-round tool for GSM development engineers, the CMU 200 is an unsurpassed solution. The RF interface provides four input and output connectors offering a wide range of signal levels for generation and analysis of RF signals. Input only, as well as combined input/output connectors, can analyze mobiles or modules with a sensitivity down to –80 dBm and up to +47 dBm for the power meter. RF signals can be generated with levels from –130 dBm up to +13 dBm, depending on the selected connector. All measurement tolerances are set by default according to the GSM 11.10 and GSM 05.05 recommendations but may of course be altered to suit individual needs. Immediately after the instrument has been switched on, user-definable hotkeys provide a fast and easy shortcut to frequently used functions, measurement results and configuration tables, presented on the clear RF-shielded 8.4" colour TFT display.

Quality assurance

For quality assurance applications, the CMU 200 offers the possibility of in-depth analysis as well as the high level of accuracy and repeatability expected of a high-end test instrument.

Tests such as simulation of specific GSM networks and dual-band handover with the corresponding signalling parameters are possible due to the comprehensive signalling configuration capabilities. GSM-specific measurements of phase and frequency error or power versus time are all available at a keystroke. For analysis of the receiver performance, BER, RBER/FER and burst by burst, as well as a BER search for absolute sensitivity verification, are available with up to 10 user-definable settings.

GSM®
GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

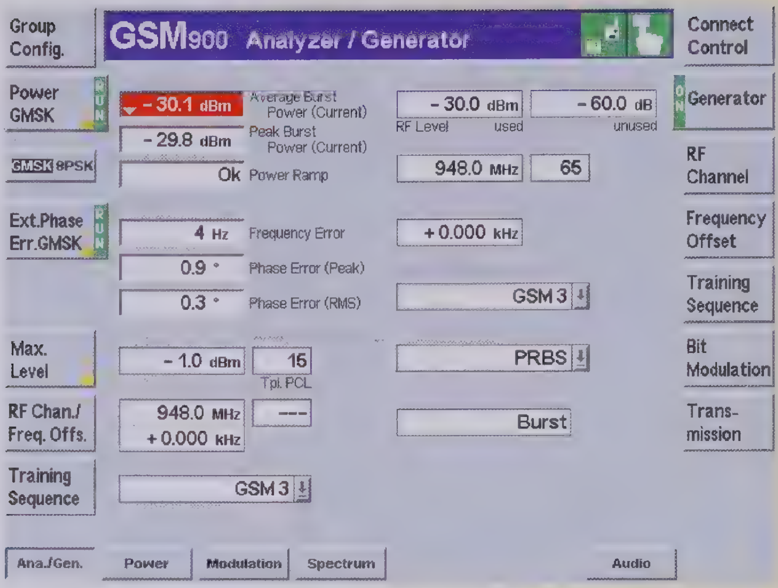
ETSI MEMBER
...making the right connections.

Production of mobile phones

Production is a process that calls for cost effectiveness. The CMU 200 concept is optimized for IEC/IEEE-bus speed, measurement accuracy and reproducibility as well as cost of ownership. Thanks to the multitasking feature and parallel measurements, previously unobtainable test times can be achieved.

The ability to process BER data and perform transmitter measurements at the same time, allows phase / frequency error, power versus time and average power (PCL accuracy) to be measured during the time-consuming receiver test. Due to the intelligence of the CMU 200 the order of measurements can be arranged so as to achieve the maximum efficiency and thus minimize test times. In case of time-consuming measurements where a statistical value is a valid indication, it is possible to fetch results during the measurement run. The measurement may be stopped if a satisfactory result has been obtained which saves valuable time. The accuracy and reproducibility ensure correct and steady measurement results and thus contribute to the quality and reliability of the end product.

GSM-specific non-signalling test provides generation and analysis of RF signals for testing of RX/TX modules or mobiles in service mode

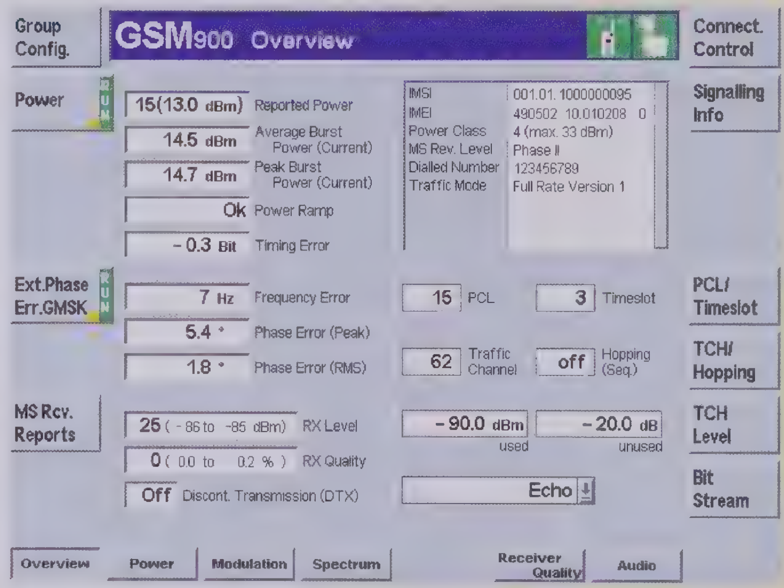

GSM900 Analyzer / Generator

- 30.1 dBm Average Burst Power (Current)
- 29.8 dBm Peak Burst Power (Current)
Ok Power Ramp
4 Hz Frequency Error
0.9 ° Phase Error (Peak)
0.3 ° Phase Error (RMS)
- 1.0 dBm 15 Tpl. PCL
948.0 MHz + 0.000 kHz ---
GSM 3

- 30.0 dBm RF Level used
- 60.0 dB unused
948.0 MHz 65
+ 0.000 kHz
GSM 3
PRBS
Burst

Group Config.
Power GMSK
RUN
GMSK 8PSK
Ext.Phase Err.GMSK
RUN
Max. Level
RF Chan./ Freq. Offs.
Training Sequence
Connect Control
ON
Generator
RF Channel
Frequency Offset
Training Sequence
Bit Modulation
Trans-mission
Ana./Gen.
Power
Modulation
Spectrum
Audio

The overview menu provides fast comprehensive information on the mobile's RF performance. The hotkeys at the bottom of the screen give immediate access to specific and detailed GSM measurements


GSM900 Overview

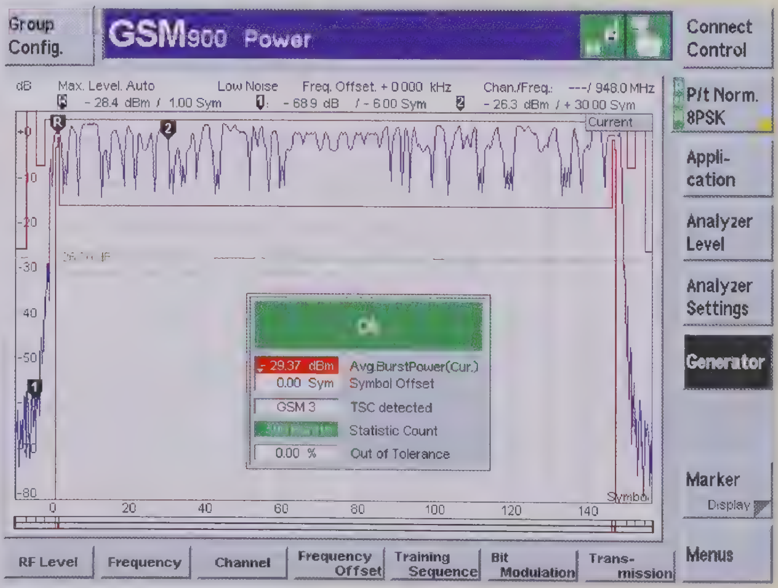
15(13.0 dBm) Reported Power
14.5 dBm Average Burst Power (Current)
14.7 dBm Peak Burst Power (Current)
Ok Power Ramp
- 0.3 Bit Timing Error
7 Hz Frequency Error
5.4 ° Phase Error (Peak)
1.8 ° Phase Error (RMS)
25 (- 86 to -85 dBm) RX Level
0 (0.0 to 0.2 %) RX Quality
Off Discont. Transmission (DTX)

IMSI 001.01. 1000000095
IMEI 490502 10.010208 0
Power Class 4 (max. 33 dBm)
MS Rev. Level Phase II
Dialled Number 123456789
Traffic Mode Full Rate Version 1

15 PCL
3 Timeslot
62 Traffic Channel
off Hopping (Seq.)
- 90.0 dBm used
- 20.0 dB unused
Echo

Group Config.
Power
RUN
Ext.Phase Err.GMSK
RUN
MS Rcv. Reports
Connect. Control
Signalling Info
PCL/ Timeslot
TCH/ Hopping
TCH Level
Bit Stream
Overview
Power
Modulation
Spectrum
Receiver Quality
Audio

In the GSM non signalling function groups the possibility to switch between GMSK and 8PSK (EDGE) is already implemented. Thus EDGE bursts as shown here can easily be analyzed


GSM900 Power

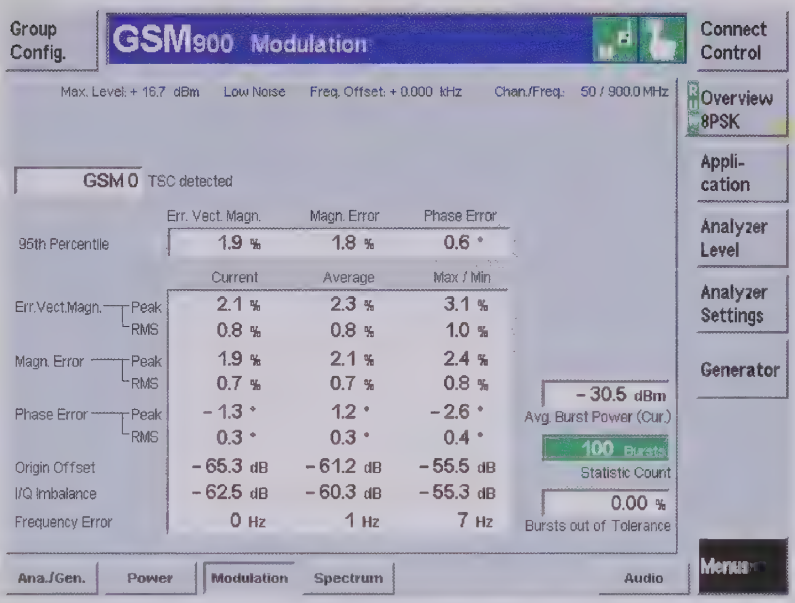
Max. Level. Auto Low Noise Freq. Offset. + 0.000 kHz Chan./Freq.: ---/ 948.0 MHz
R - 28.4 dBm / 1.00 Sym 1: - 68.9 dB / - 6.00 Sym 2 - 26.3 dBm / + 30.00 Sym

Ok
- 29.37 dBm Avg.BurstPower(Cur.)
0.00 Sym Symbol Offset
GSM 3 TSC detected
Statistic Count
0.00 % Out of Tolerance

dB
+0
-10
-20
-30
40
-50
-80
R
2
1
Current
0
20
40
60
80
100
120
140
Symbol
Group Config.
Connect Control
P/t Norm. 8PSK
Appli-cation
Analyzer Level
Analyzer Settings
Generator
Marker
Display
Menus
RF Level
Frequency
Channel
Frequency Offset
Training Sequence
Bit Modulation
Trans-mission

GSM Evolution – 2.5G

The amount of data transfer in GSM networks is growing rapidly. Quite simply, the current data transfer capacity of GSM will not be sufficient in the future. Multislot applications such as HSCSD or GPRS together with the innovative 8 PSK modulation scheme EDGE are needed to cater for the evolving data traffic. The CMU200 platform is not only able to meet today's standards and systems but is also designed for the needs of tomorrow. Tests in both circuit switched and packet oriented connections are implemented in the CMU200 GSM function groups, EDGE signals can already be generated and analyzed.



Max. Level: + 16.7 dBm Low Noise Freq. Offset: + 0.000 kHz Chan./Freq.: 50 / 900.0 MHz

GSM 0 TSC detected

		Err. Vect. Magn.	Magn. Error	Phase Error
95th Percentile		1.9 %	1.8 %	0.6 °
		Current	Average	Max / Min
Err.Vect.Magn.	Peak	2.1 %	2.3 %	3.1 %
	RMS	0.8 %	0.8 %	1.0 %
Magn. Error	Peak	1.9 %	2.1 %	2.4 %
	RMS	0.7 %	0.7 %	0.8 %
Phase Error	Peak	- 1.3 °	1.2 °	- 2.6 °
	RMS	0.3 °	0.3 °	0.4 °
Origin Offset		- 65.3 dB	- 61.2 dB	- 55.5 dB
I/Q Imbalance		- 62.5 dB	- 60.3 dB	- 55.3 dB
Frequency Error		0 Hz	1 Hz	7 Hz

- 30.5 dBm
Avg. Burst Power (Cur.)
100 Bursts
Statistic Count
0.00 %
Bursts out of Tolerance

In the 8PSK mode the modulation analysis is subdivided. The error vector magnitude, the magnitude error and the phase error can be displayed both numerical as shown above, or graphical.

Multislot

In the future, mobile phones will be able to use several timeslots simultaneously for data transmission to further increase the data rate. For multislot phones, the CMU supports measurements in a number of timeslots, taking into account any interference from active, neighbouring timeslots. From special multislot menus, simultaneous measurement of the average burst power of all eight timeslots within one frame can be selected for instance. The results are displayed as graphs or tables. Multislot measurements are required for HSCSD technologies and for GPRS.

8PSK modulation – EDGE

8PSK is another step towards increasing the mobile radio data rate. By using the available GSM frame structure, the gross data rate is three times that obtained with GMSK. The CMU200 can already perform 8PSK on GSM bursts and analyze them thanks to advanced measurement applications. Error vector magnitude and magnitude error have been added to the range of modulation measurements. New templates for power-versus-time measurements ensure compliance with the specifications, as do the modified tolerances for spectrum measurements. 8PSK will transform HSCSD technologies into ECSD and GPRS into EGPRS. As with all measurements provided by the CMU200, special attention has been given to achieving maximum measurement accuracy and speed for EDGE too.

GPRS/EGPRS

Thanks to the new, future-oriented method of packet data transmission, the radio

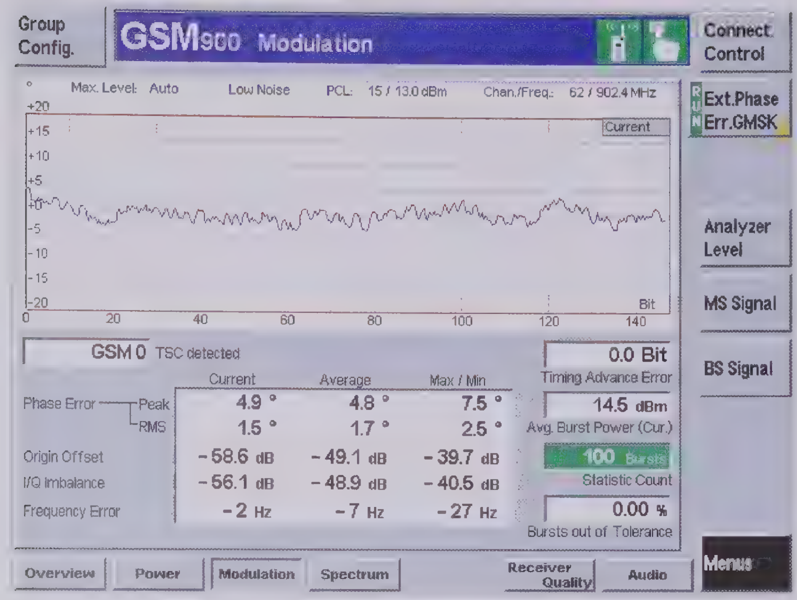
GSM specifications – Mobile station test

RF generator

Modulation	GMSK, BxT = 0.3 8PSK
Frequency range	
GSM 400 band	460 MHz to 468 MHz / 488 MHz to 496 MHz
GSM850	869 MHz to 894 MHz
GSM900 band	921 MHz to 960 MHz
GSM1800 band	1805 MHz to 1880 MHz
GSM1900 band	1930 MHz to 1990 MHz
Attenuation of inband spurious emissions	>50 dB
Inherent phase error (GMSK)	<1°, rms <4°, peak
Inherent EVM (8PSK)	<2%, rms
Frequency settling time	<500 µs to res. phase of 4°
Output level range (GMSK)	
RF1	–130 dBm to –27 dBm
RF2	–130 dBm to –10 dBm
RF3OUT	–90 dBm to +13 dBm
Output level range (8PSK)	
RF1	–130 dBm to –31 dBm
RF2	–130 dBm to –14 dBm
RF3OUT	–90 dBm to +9 dBm
Output level resolution	0.1 dB
Output level uncertainty	
RF1, RF2: > –117 dBm	
in temperature range +23°C to +35°C	<0.5 dB
in temperature range +5°C to +45°C	<0.7 dB
RF3OUT –90 dBm to +10 dBm (GMSK) –90 dBm to +6 dBm (8PSK)	
in temperature range +23°C to +35°C	<0.7 dB
in temperature range +5°C to +45°C	<0.9 dB

RF analyzer

Frequency range	
GSM 400 band	450 MHz to 458 MHz / 478 MHz to 486 MHz
GSM850	869 MHz to 894 MHz
GSM900 band	876 MHz to 915 MHz
GSM1800 band	1710 MHz to 1785 MHz
GSM1900 band	1850 MHz to 1910 MHz
Measurement bandwidth	
in measurement menus	500 kHz



Max. Level: Auto Low Noise PCL: 15 / 13.0 dBm Chan./Freq.: 62 / 902.4 MHz

GSM 0 TSC detected

		Current	Average	Max / Min
Phase Error	Peak	4.9 °	4.8 °	7.5 °
	RMS	1.5 °	1.7 °	2.5 °
Origin Offset		- 58.6 dB	- 49.1 dB	- 39.7 dB
I/Q Imbalance		- 56.1 dB	- 48.9 dB	- 40.5 dB
Frequency Error		- 2 Hz	- 7 Hz	- 27 Hz

Timing Advance Error: 0.0 Bit
Avg. Burst Power (Cur.): 14.5 dBm
Statistic Count: 100 Bursts
Bursts out of Tolerance: 0.00 %

The performance of the GSM mobile or module synthesizer is monitored in the phase and frequency error menu. A pass / fail verdict is immediately available due to the red colouring of those measurement results that are outside the user-configurable limits. Statistical evaluation of measurement results over up to 1000 bursts as well as stop-on-error conditions ease the task of assessing a product in any application

resources of existing GSM mobile radio networks can be utilized efficiently for data services. As with circuit-switched services, GPRS will also use a combination of several timeslots (multislots) and higher-level modulation in the form of 8PSK (EGPRS) to push up the data rate. Shorter packets are also used. Extremely fast adjustment and testing of RF parameters during GPRS mobile phone production is ensured by deactivating the GPRS protocol stack. Without using the higher protocol layer (RLC/MAC layer), the CMU 200 synchronizes the mobile (camping), the data channel (PDCH) is then set up directly.

The GPRS and EGPRS data coders are already available to determine Bit Error Rates (BER) and Data Block Error Rates (DBLER).

Signalling with the full GPRS protocol (RLC/MAC layer) will soon also be available as an option. Implementing extended ETSI specifications (GSM Recommendation 04.14), the CMU 200 will support a test mode for setting up a measurement channel (TBF).

GSM highlights of CMU200

Benchmark-breaking IEEE-bus speed due to

- Parallel measurements
- Secondary addressing
- Optimized processing power

Base station simulation including

- BS_AG_BLK_RES, BS_PA_MFRMS, DTX, cell access, MCC, MNC, NCC, BCC, location area, BA list, hopping, radio link timeout for mobile/base station, AOC

More features

- Location update (display of IMEI and IMSI)
- Call to/from mobile
- Call termination from mobile /network
- Channel, timeslot, PCL band handover
- BCCH, SACCH, SDCCH, FACCH, TCH, PDCH

GMSK/8PSK Measurements

- Phase / frequency error, EVM, magnitude error, origin offset, I/Q imbalance for I/Q modulator tuning
- Power vs time normal/access
- Peak power/average, power vs frame, power vs slot
- General spectrum measurements
- Timing error
- BER/DBLER, RBER/FER, FastBER
- Power vs PCL (on 3 or 7 channels)

Power meter (frequency-selective)

Level range	
RF1	
continuous power[1]	–40 dBm to +47 dBm (50 W)
Peak Envelope Power[2] (PEP)	+53 dBm (200 W)
RF2	
continuous power	–54 dBm to +33 dBm (2 W)
Peak Envelope Power[2] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	–80 dBm to 0 dBm
Level uncertainty	
RF1, RF2, RF4IN	
in temperature range +23 °C to +35 °C	<0.5 dB
in temperature range +5 °C to +45 °C	<0.7 dB
Level resolution	0.1 dB (0.01 dB via remote control)

Modulation analysis

Level range (PEP)	
RF1	–6 dBm to +53 dBm
RF2	–20 dBm to +39 dBm
RF4IN	–60 dBm to 0 dBm
Inherent phase error (GMSK)	<0.6°, rms <2°, peak
Inherent EVM (8PSK)	<1,0 %, rms
Frequency measurement uncertainty	≤10 Hz + drift of time base

Burst power measurement

Reference level for full dynamic range (GMSK, low noise mode)	
RF1	+10 dBm to +53 dBm
RF2	–4 dBm to +39 dBm
RF4IN	–22 dBm to 0 dBm
Dynamic range (GMSK)	>72 dB (BW=500 kHz, rms)
Reference level for full dynamic range (8PSK, low noise mode)	
RF1	+6 dBm to +49 dBm
RF2	–8 dBm to +35 dBm
RF4IN	–26 dBm to –4 dBm
Dynamic range	>69 dB (BW = 500 kHz, rms)
Relative measurement uncertainty	
Result > –40 dB	<0.1 dB
–60 dB ≤result≤–40 dB	<0.5 dB
Resolution	0.1 dB in active part of burst

[1] 50 W from +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.

[2] Mean value of power vs time must be equal or less than allowed continuous power.

TDMA in CMU200

The need for higher data rates is the trend in our information-oriented society in the new millennium. The enhancement of mobile phones takes this need into account on the way to the next generation of wireless communication. Need to test these future improvements?

CMU200 does it all. The TDMA part takes care of your requirements to cope with this fast progressing mobile technology. The CMU200 concept with its multistandard platform architecture provides for further extensions such as *Bluetooth* and cdma2000.

TDMA

The wide acceptance of TDMA (IS-136) is based on a very flexible and powerful technology as well as on its compatibility with AMPS, which is widespread and one of the major wireless communication standards. Derived from analog AMPS, the TDMA standard is now ready for a step-by-step evolution into the third generation of mobile technology. This fact shows the need for a test instrument that is flexible enough to cover all future needs as well as the current standards.

For TDMA (IS-136) signalling functionality, the CMU200 requires the versatile signalling unit (CMU-B21) as well as the software option CMU-K27 for the cellular band or CMU-K28 for the PCS band.

Due to the highly user-friendly menu concept, the CMU200 provides quick access to all measurements desired, optimizing handling and consequently efficiency.

Signalling mode

The CMU200 simulates a TDMA base-station RF interface including the signalling protocol so that a mobile can be tested with regard to different signalling parameters. All necessary network and base-station parameters can be set, such as control and traffic channel configuration, neighbouring channels setup etc. You can also generate a MAHO report.

Non-signalling mode

The non-signalling mode is for generating and analyzing TDMA (IS-136) signals within the frequency range from 10 MHz to 2.7 GHz. CMU200 provides TDMA-specific measurements such as:

- Power
- Modulation
- Spectrum
- Power versus time
- BER

TDMA (IS-136) development

With its great versatility the CMU 200 is the most suitable tool for the development of mobile phones. Four configurable RF connectors are provided to enable flexible signal generation and analysis. The power meter can evaluate signals within a range from –80 dBm to 47 dBm, whereas the generator outputs signals from –130 dBm to 13 dBm. The clearly structured and user-friendly menu design together with the clear-cut screen layout provides quick access to all features and ensures trouble-free monitoring of the device under test.

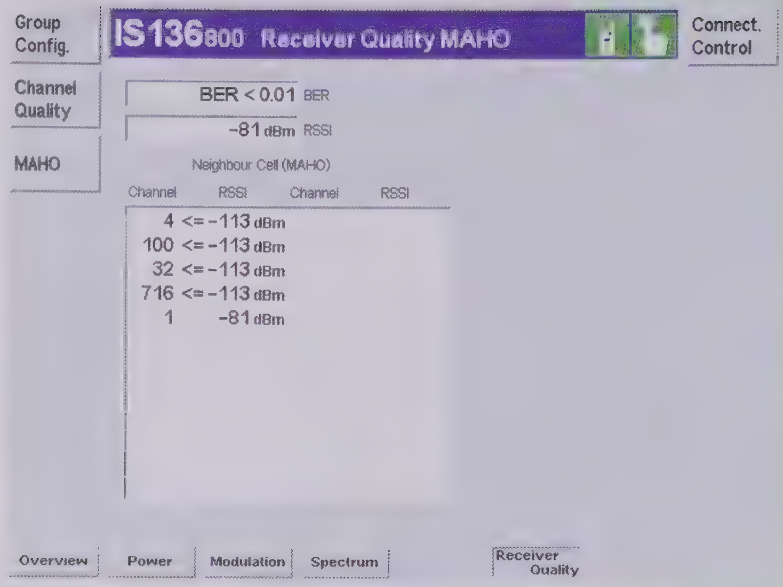
Quality assurance

Due to its high measurement repeatability and accuracy, the CMU200 is the right choice to ensure a consistently high quality standard from production. TDMA-specific measurements such as BER, Error Vector Magnitude (EVM) and EVM10, where only the first 10 symbols are taken into account, provide an excellent test platform to guarantee the production of high-quality devices.

Production of mobile phones

The production of mobile phones requires time-efficient and cost-effective means that ensure both high throughput and state-of-the-art accuracy. Thanks to the unique IEC/IEEE-bus concept of the CMU200, these two goals can be easily achieved in your production line. The intelligent handling of the received GPIB commands optimizes the measurement speed for all TDMA-specific measurements. In practice, this will mean drastically enhanced test time and test yield.

The mobile reports the received signal strength (RSSI) of the observed channels back to the CMU where the RSSI is displayed in the MAHO report list. It is possible to configure the neighbouring channels in the network setup. The reported BER can also be monitored


Group Config.
IS136 800 Receiver Quality MAHO
Connect. Control
Channel Quality
MAHO
Overview
Power
Modulation
Spectrum
Receiver Quality

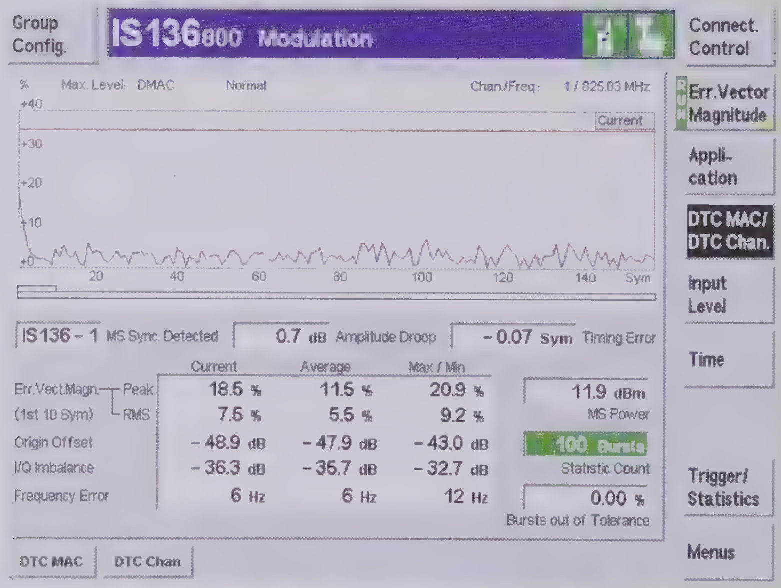
BER < 0.01 BER

-81 dBm RSSI

Neighbour Cell (MAHO)

Channel	RSSI	Channel	RSSI
4	<= -113 dBm		
100	<= -113 dBm		
32	<= -113 dBm		
716	<= -113 dBm		
1	-81 dBm		

In the modulation menu it is possible to measure the phase error, frequency error and the error vector magnitude. The measurements results are displayed graphically. Additional measurements such as amplitude droop and timing error are taken as well and displayed numerically in the same screen


Group Config.
IS136 800 Modulation
Connect. Control
%
Max. Level: DMAC
Normal
Chan./Freq.: 1 / 825.03 MHz
Current
+40
+30
+20
+10
+0
20
40
60
80
100
120
140
Sym
Err.Vector Magnitude
Appli-cation
DTC MAC/ DTC Chan.
Input Level
Time
Trigger/ Statistics
Menus
DTC MAC
DTC Chan

IS136 - 1 MS Sync. Detected

0.7 dB Amplitude Droop

- 0.07 Sym Timing Error

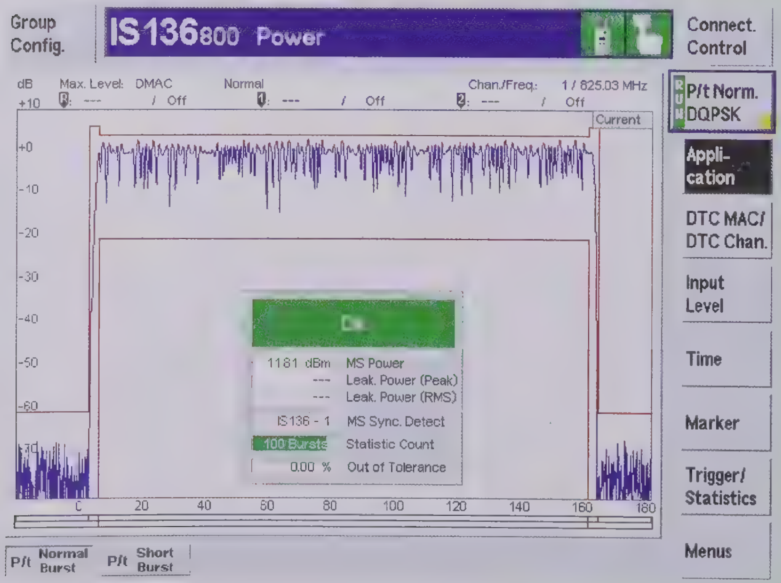
		Current	Average	Max / Min
Err.Vect.Magn. (1st 10 Sym)	Peak	18.5 %	11.5 %	20.9 %
	RMS	7.5 %	5.5 %	9.2 %
Origin Offset		- 48.9 dB	- 47.9 dB	- 43.0 dB
I/Q Imbalance		- 36.3 dB	- 35.7 dB	- 32.7 dB
Frequency Error		6 Hz	6 Hz	12 Hz

11.9 dBm MS Power

100 Bursts Statistic Count

0.00 % Bursts out of Tolerance

In the power menu, the mobile output power of the short burst or the normal burst is displayed. CMU also enables leakage power measurements which inform on the mobile power output in unused time slots


Group Config.
IS136 800 Power
Connect. Control
dB
Max. Level: DMAC
Normal
Chan./Freq.: 1 / 825.03 MHz
+10
--- / Off
--- / Off
--- / Off
Current
+0
-10
-20
-30
-40
-50
-60
-70
0
20
40
60
80
100
120
140
160
180
P/t Norm. DQPSK
Appli-cation
DTC MAC/ DTC Chan.
Input Level
Time
Marker
Trigger/ Statistics
Menus
P/t Normal Burst
P/t Short Burst

Ok

11.81 dBm MS Power

--- Leak. Power (Peak)

--- Leak. Power (RMS)

IS136 - 1 MS Sync. Detect

100 Bursts Statistic Count

0.00 % Out of Tolerance

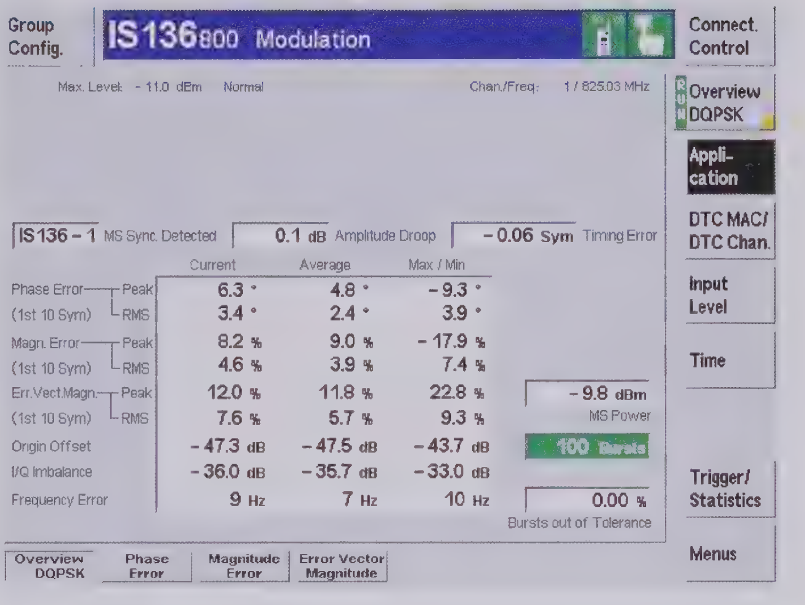
TDMA in CMU200

Handoffs

Handoffs are part of the IS-136 specification. Handoffs between PCS and cellular bands as well as from and to AMPS are defined and have to be tested. CMU200 supports handoffs from IS-136 800 MHz to 1900 MHz (inter-band handoff) and vice versa. Handoffs from 1900 MHz or 800 MHz to AMPS and back are also possible (inter-mode handoff) with CMU200.

Switching standards

The flexibility of CMU200 makes for quick and simple switching between two different standards. This is very important for IS-136, which is a dual-mode standard containing a digital (TDMA) and an analog mode (AMPS). The handoff between TDMA and AMPS can be achieved by simply pressing a button. This results in a very versatile test concept to improve the flexibility and throughput of your production line.



Max. Level: - 11.0 dBm Normal

Chan./Freq: 1 / 825.03 MHz

IS136 - 1 MS Sync. Detected

0.1 dB Amplitude Droop

- 0.06 Sym Timing Error

		Current	Average	Max / Min
Phase Error (1st 10 Sym)	Peak	6.3 °	4.8 °	- 9.3 °
	RMS	3.4 °	2.4 °	3.9 °
Magn. Error (1st 10 Sym)	Peak	8.2 %	9.0 %	- 17.9 %
	RMS	4.6 %	3.9 %	7.4 %
Err.Vect.Magn. (1st 10 Sym)	Peak	12.0 %	11.8 %	22.8 %
	RMS	7.6 %	5.7 %	9.3 %
Origin Offset		- 47.3 dB	- 47.5 dB	- 43.7 dB
I/Q Imbalance		- 36.0 dB	- 35.7 dB	- 33.0 dB
Frequency Error		9 Hz	7 Hz	10 Hz

- 9.8 dBm MS Power

100 Bursts

0.00 % Bursts out of Tolerance

In the modulation overview menu, error vector magnitude (EVM), phase error and magnitude error are measured simultaneously and displayed in a numerical table It is possible to choose either EVM, where the whole burst is considered, or EVM10, where only the first ten symbols are taken into account

TDMA specifications – Mobile station test

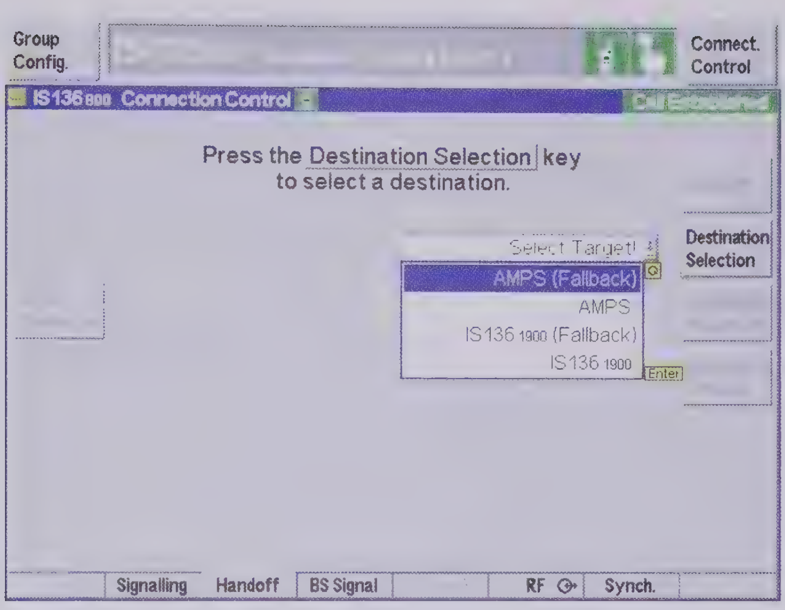
RF generator

Frequency range signalling mode	
US Cellular	869 MHz to 894 MHz
PCS (US)	1930 MHz to 1990 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base
Output level range	
RF1	–130 dBm to –32 dBm
RF2	–130 dBm to –15 dBm
RF3OUT	–90 dBm to +8 dBm
Output level resolution	0.1 dB
Output level uncertainty	see CMU200 base unit

Modulation	
π/4 DQPSK or unmodulated (non-signalling mode)	
Uncertainty	<2.5% (EVM rms)
Carrier suppression	>40 dB

RF analyzer

Frequency range signalling mode	
US Cellular	824 MHz to 849 MHz
PCS (US)	1850 MHz to 1910 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base
Modulation analyzer	
824 MHz to 849 MHz and 1850 MHz to 1910 MHz	
EVM, rms (residual)	<2%
EVM, peak (residual)	<4%
I/Q offset (residual)	<–50 dB (0.3%)
I/Q imbalance (residual)	<–50 dB (0.3%)
Frequency measurement range	–2 kHz to +2 kHz
Frequency measurement error	≤5 Hz + drift of time base


Group Config.
Connect. Control
IS136 800 Connection Control
Destination Selection
Select Target!
AMPS (Fallback)
AMPS
IS136 1900 (Fallback)
IS136 1900
Enter
Signalling
Handoff
BS Signal
RF
Synch.

Press the Destination Selection key to select a destination.

Handoffs from cellular band (800 MHz) to PCS band (1900 MHz) can be tested as well as to and from AMPS. Before handing off to a new network the parameters for the target network can be set. This results in a large variety of different test scenarios

TDMA highlights of CMU200

Basic features

- Call to / from mobile
- Handoff to AMPS
- Dual-band handoff

Signalling measurements

- MAHO report
- Power versus time
  - Short burst
  - Normal burst
- Modulation
  - Phase error
  - Magnitude error
  - EVM/EVM10
  - Overview of phase / magnitude and EVM simultaneously
- Spectrum
  - Adjacent channel power due to switching/due to modulation
- Overview
  - Signalling information

Non-signalling measurements

- Modulation
- Spectrum
- Power versus time
- BER

Power meter (frequency-selective)

Level uncertainty	see CMU200 base unit

Power versus time measurement

Reference level for full dynamic range (low noise mode)	
RF1	+4 dBm to +47 dBm
RF2	–10 dBm to +33 dBm
RF4IN	–28 dBm to –6 dBm
Dynamic range	>74 dB (BW=100 kHz, rms)
Relative measurement uncertainty	
Result >–40 dB	<0.1 dB
–60 dB≤ Result ≤–40 dB	<0.5 dB
Residual leakage power level	<–65 dBm
Adjacent channel power measurement	
Dynamic range	
1st adjacent channel	>45 dB
2nd and 3rd adjacent channel	>55 dB

AMPS in CMU200

AMPS overview

Analog AMPS (advanced mobile phone system) is a standard system for analog cellular telephone service in the United States and is also used in other countries. It is based on the frequency spectrum allocation for cellular service by the Federal Communications Commission (FCC) in 1970. Introduced by AT&T in 1983, AMPS became the most widely deployed cellular system in the United States.

AMPS options

Although AMPS is a 1st generation analog standard, a great demand for mobile radio testers covering this standard will continue to exist in the future. Especially in the United States, dual-mode CDMA/AMPS and TDMA/AMPS phones are very common. By combining the digital standards with analog AMPS, the network operators offer their customers the advantages of the digital standards and ensure nearly 100% coverage in North America. As a consequence, Rohde & Schwarz is extending the range of CMU200 options by introducing analog AMPS in addition to the digital standards TDMA and CDMA. These options add analog AMPS functionality to the CMU200 base unit:

- CMU-B21 (versatile link handler)
- CMU-B41 (audio generator/analyzer)
- CMU-K29 (AMPS test software)

The hardware options CMU-B21 (versatile link handler) and CMU-B41 (audio generator/analyzer) are suited for other standards as well.

AMPS measurements and features

As for other standards, there are two categories of AMPS measurements:

- Transmitter tests for assessing the transmit part of a mobile
- Receiver tests for assessing the receive part of a mobile
- AF Level Search routine
- Sensitivity Search routine

The AF Level Search routine in the TX test menu allows the user to set the desired frequency deviation of the mobile transmitter at a keystroke, the level of the CMU200 modulation generator is automatically corrected.

The Sensitivity Search routine in the RX test menu automatically searches the receiver input level at which a selectable SINAD of the demodulated signal can still be attained. The following list provides an overview of the most important tests implemented in option CMU-K29.

Transmitter measurements

- Carrier power
- Carrier frequency error
- SAT frequency error/peak deviation
- ST frequency error/peak deviation
- Modulation noise and distortion
- Hum and noise
- Electrical audio frequency response
- Modulation distortion
- Residual AM

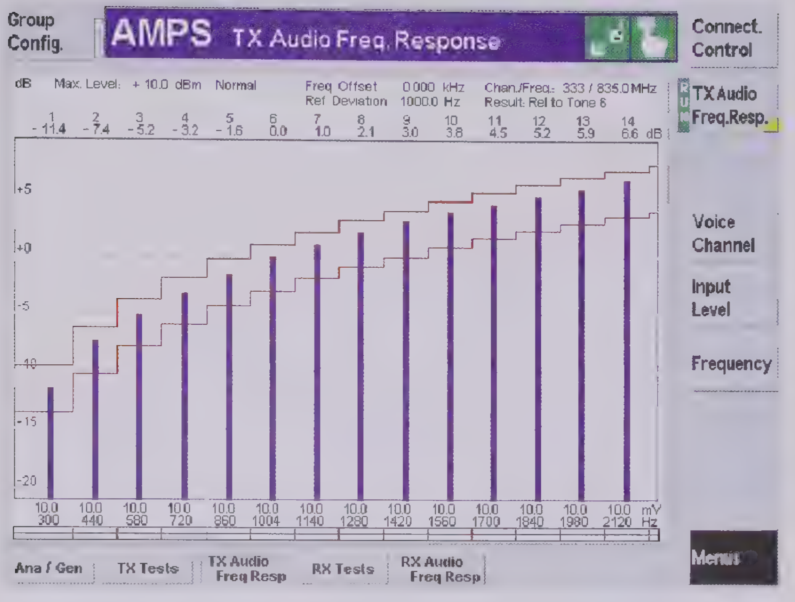
Receiver measurements

- Sensitivity
- Hum and noise
- SINAD
- Distortion
- AF voltage
- Electrical audio frequency response
- Residual AM
- Audio deviation

AMPS specifications – Mobile station test

RF Generator

Frequency range signalling mode	
US Cellular	869 MHz to 894 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base
Output level range	
RF1	–130 dBm to –27 dBm
RF2	–130 dBm to –10 dBm
RF3OUT	–90 dBm to +13 dBm
Output level resolution	0.1 dB
Output level uncertainty	see CMU200 base unit (add 0.1 dB)
Modulation	
FM deviation range	100 Hz to 20 kHz
FM resolution	1 Hz
AF range	100 Hz to 15.999 kHz



AMPS TX Audio Freq. Response

Max. Level: + 10.0 dBm Normal

Freq Offset 0.000 kHz

Ref Deviation 1000.0 Hz

Chan./Freq.: 333 / 835.0 MHz

Result: Rel to Tone 6

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
dB	- 11.4	- 7.4	- 5.2	- 3.2	- 1.6	0.0	1.0	2.1	3.0	3.8	4.5	5.2	5.9	6.6
mV	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Hz	300	440	580	720	860	1004	1140	1280	1420	1560	1700	1840	1980	2120

TX audio frequency response measurement. The pre-emphasis characteristic of the mobile transmitter is verified by a single-shot measurement

All the filters required for the measurements are of course preconfigured in line with specifications, but their settings can be modified for individual measurements. The RX and TX electrical audio frequency response measurements in AMPS are usually defined as frequency sweep versus AF frequency range. The CMU 200 offers a much faster and more modern alternative. Using the TX and RX audio frequency response menus of CMU 200, the AF frequency response is measured simultaneously at 20 test points with user-programmable level and frequency and then checked against specified tolerances (see screenshot above).

AMPS highlights of CMU200

Benefits of base unit

- Platform supporting CDMA, TDMA and AMPS within one box
- Wide frequency range allowing dual mode/dual band testing required for CDMA and TDMA
- See base unit section

AMPS features

- Powerful signalling capabilities
- Base station simulation
- Mobile or base station originated call connect/disconnect
- Short measurement time ensuring high throughput
- Combined measurements
- Benchmark-breaking IEEE-bus speed (see GSM highlights)
- Simple interactive operation, standardized MMI
- No specialized network knowledge required
- Various handoffs from CDMA/TDMA and to TDMA supported

FM distortion (SINAD; dev. 8 kHz, AF 1 kHz, BW 30 Hz to 15 kHz)	≥40 dB
Residual FM (rms, BW 300 Hz to 3 kHz)	≤10 Hz
Deviation uncertainty at 1kHz AF, 8kHz dev.(measurement bandwidth 30 Hz to 15 kHz)	<2 % of setting + residual FM
Deviation frequency response at 300 Hz to 15.999 kHz AF	≤0.5 dB

RF analyzer

Frequency range signalling mode	
US Cellular	824 MHz to 849 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base

Power meter (frequency-selective)

Reference Level Range	
RF1	0 dBm to +53 dBm
RF2	–14 dBm to +39 dBm
RF4IN	–37 dBm to 0 dBm
Level uncertainty	see CMU 200 base unit
Level resolution	0.1 dB

FM measurement

Dynamic range	30 dB below reference level
RF bandwidth (2 x deviation + 4 x AF)	136 kHz
Deviation range	0 kHz to 47 kHz
Resolution	1 Hz
AF range	100 Hz to 18 kHz
Residual FM	
BW 300 Hz to 3 kHz, rms	≤5 Hz
BW 6 Hz to 20 kHz, rms	≤18 Hz
Uncertainty (BW 6 Hz to 20 kHz)	<1% of reading + residual FM
Carrier frequency error measurement range	–47 kHz to +47 kHz
Carrier frequency error measurement uncertainty	≤2 kHz + drift of time base

AF generator

see CMU 200 base unit (Audio option CMU-B41)

AF analyzer

see CMU 200 base unit (Audio option CMU-B41)

CDMA in CMU200

CDMA overview

Code division multiple access (CDMA) – once a radically new concept in wireless communication – has meanwhile become a well established standard in the world of mobile communication. CDMA has proven its advantages and capabilities and has gained widespread international acceptance.

Instead of using frequencies or timeslots as traditional technologies like TDMA and AMPS do, CDMA uses mathematical codes to transmit and distinguish between multiple wireless conversations. Depending on the level of mobility, CDMA provides 8 to 10 times the capacity of AMPS and 4 to 5 times the capacity of TDMA systems. CDMA can efficiently utilize the spectrum and serve many subscribers without requiring extensive frequency planning.

History

Since the startup of the first commercial cdmaOne network in Hong Kong in September 1995 CDMA has established itself as a worldwide mobile radio standard. It has not only been successful in its country of origin, the USA, as well as in Korea and Japan, but all over the world. With its still booming growth rates CDMA today is – besides GSM – one of the most important digital 2nd generation mobile radio standards. CDMA is therefore also suited as the leading-edge technology on the way to 3rd generation mobile radio.

CDMA options

Taking the current development on the market into account, Rohde & Schwarz has extended the proven modular concept of the CMU200 with CDMA functionality. The following options make the CMU200 a compact radio communication tester for all TIA/EIA-95-based CDMA mobile phones:

- CMU-B81 (CDMA link handler)
- CMU-K81 (CDMA, cellular)
- CMU-K82 (CDMA, PCS)

CMU200 is also the first choice as a tester for CDMA – especially in harsh production environments – because of its outstanding measurement speed, ultra-high accuracy and unrivalled reliability which is also a result of the innovative ventilation concept. Thanks to the modular concept of CMU200, CDMA functionality plus GSM, TDMA (TIA/EIA-136), AMPS and other standards such as *Bluetooth* can be implemented in a single unit. Which other radio communication tester can boast such superior features?

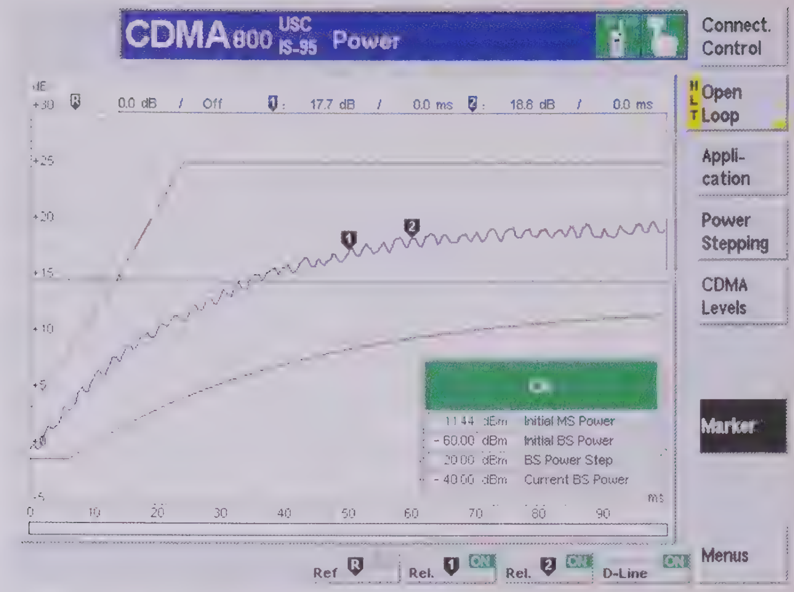
CDMA functionality

In CDMA mode, the tests are based on the TIA/EIA-95A, TSB-74, and J-STD-008 CDMA airlink standards. In addition, the CDMA option supports also the standards ARIB-T53 and Korean PCS. The tester emulates a code division multiple access base station, makes a call to the mobile, and tests all essential parameters of a CDMA mobile station. The tester can measure the following key parameters among other tests:

- Power control measurements:
  - Open-loop time response
  - Gated output power
  - Minimum output power
  - Maximum output power
- Receiver quality measurements:
  - Frame error rate (FER)
  - With additional AWGN generator to simulate noise caused by other CDMA calls at the same frequency
- Transmitter quality measurements:
  - Waveform quality
  - Error vector magnitude
  - Phase error
  - Magnitude error
  - Carrier feedthrough and I/Q imbalance
  - Frequency accuracy

Open-loop time response

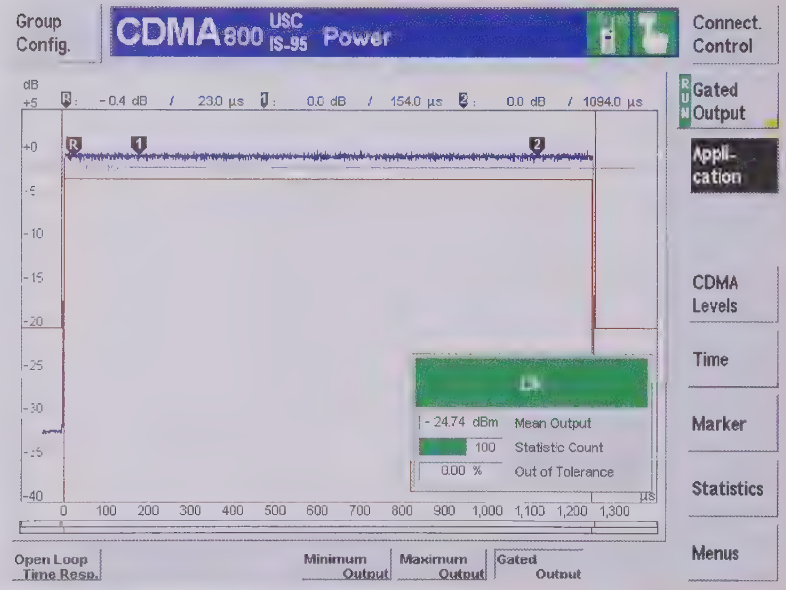
The open-loop power control test shows the response of the mobile station to an increase or decrease in base-station total power. The default increase or decrease for this test is 20 dB. Power stepping and CDMA levels are user-definable


CDMA 800 USC IS-95 Power
Connect. Control
Open Loop
Appli-cation
Power Stepping
CDMA Levels
Marker
Menus
dB
0.0 dB / Off
17.7 dB / 0.0 ms
18.6 dB / 0.0 ms
+30
+25
+20
+15
+10
+5
+0
-5
0 10 20 30 40 50 60 70 80 90
ms
Ok
Ref
Rel.
Rel.
D-Line
ON

11.44	dBm	Initial MS Power
- 60.00	dBm	Initial BS Power
20.00	dBm	BS Power Step
- 40.00	dBm	Current BS Power

Gated output power

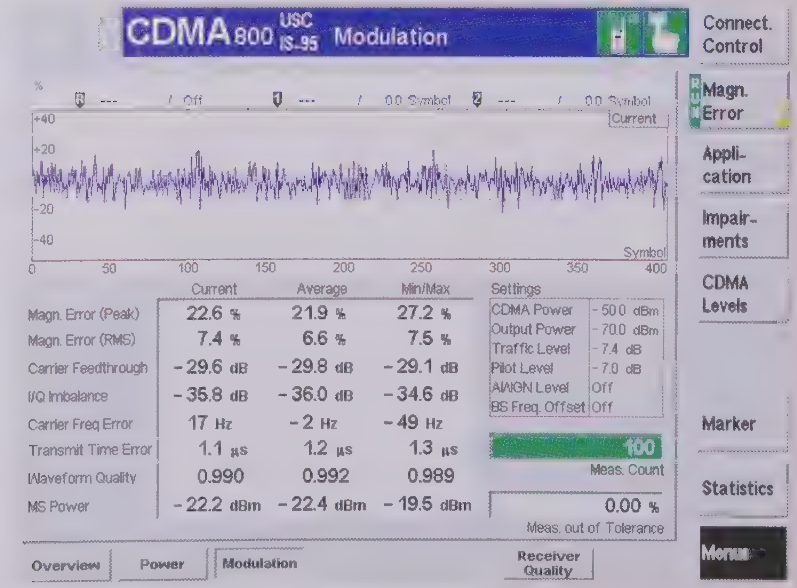
The gated output power can be displayed in several formats. Select FULL DISPLAY to show the total period of the IS-98 gated output template. The period of the full display is approx. 1500 µs. Select RISING EDGE (see figure) or FALLING EDGE to zoom in to display the 17 ms period of the rising or falling edge of the waveform. In each of these displays, a MARKER may be activated to display both power amplitude and relative time


Group Config.
CDMA 800 USC IS-95 Power
Connect. Control
Gated Output
Appli-cation
CDMA Levels
Time
Marker
Statistics
Menus
dB
-0.4 dB / 23.0 µs
0.0 dB / 154.0 µs
0.0 dB / 1094.0 µs
+5
+0
-5
-10
-15
-20
-25
-30
-35
-40
0 100 200 300 400 500 600 700 800 900 1,000 1,100 1,200 1,300
µs
Ok
Open Loop Time Resp.
Minimum Output
Maximum Output
Gated Output

- 24.74	dBm	Mean Output
100		Statistic Count
0.00	%	Out of Tolerance

Modulation measurements magnitude error

Modulation measurements serve for assessing the quality of the mobile's transmit part. In addition to phase error, error vector magnitude and magnitude error can be shown graphically at the push of a button. A clearly arranged table lists carrier feedthrough, IQ imbalance, frequency error and waveform quality with current measurement results, average and minimum/maximum values


CDMA 800 USC IS-95 Modulation
Connect. Control
Magn. Error
Appli-cation
Impair-ments
CDMA Levels
Marker
Statistics
Menus
%
--- / Off
--- / 0.0 Symbol
--- / 0.0 Symbol
Current
+40
+20
-20
-40
0 50 100 150 200 250 300 350 400
Symbol
Overview
Power
Modulation
Receiver Quality

	Current	Average	Min/Max
Magn. Error (Peak)	22.6 %	21.9 %	27.2 %
Magn. Error (RMS)	7.4 %	6.6 %	7.5 %
Carrier Feedthrough	- 29.6 dB	- 29.8 dB	- 29.1 dB
I/Q Imbalance	- 35.8 dB	- 36.0 dB	- 34.6 dB
Carrier Freq Error	17 Hz	- 2 Hz	- 49 Hz
Transmit Time Error	1.1 µs	1.2 µs	1.3 µs
Waveform Quality	0.990	0.992	0.989
MS Power	- 22.2 dBm	- 22.4 dBm	- 19.5 dBm

Settings	
CDMA Power	- 50.0 dBm
Output Power	- 70.0 dBm
Traffic Level	- 7.4 dB
Pilot Level	- 7.0 dB
AWGN Level	Off
BS Freq. Offset	Off

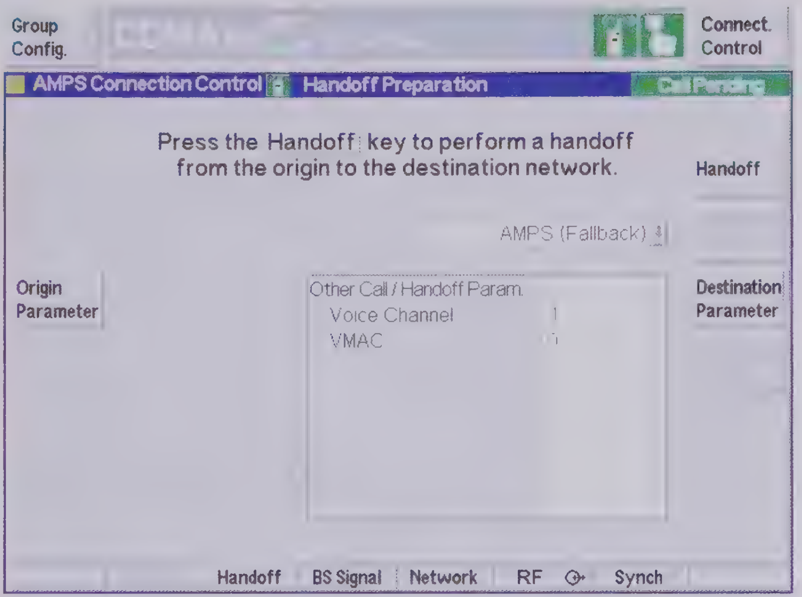
100
Meas. Count

0.00 %
Meas. out of Tolerance

CDMA in CMU200

CDMA know-how

Rohde & Schwarz is not a newcomer in the field of CDMA, but has many years of experience. As early as 1996 Rohde & Schwarz and Tektronix launched a professional radio tester for CDMA mobiles. Worldwide this extremely successful tester sold thousands of units and has undergone permanent enhancement and adaptation to remain state-of-the-art. CMU200 builds on this success and is able to perform CDMA mobile station tests using thoroughly proven test and measurement methods, and also offers the possibility of enhancements for future technologies.



Press the Handoff key to perform a handoff from the origin to the destination network.

AMPS (Fallback)

Other Call / Handoff Param.
Voice Channel 1
VMAC 0

CMU200 offers a separate menu for handoffs. In addition to handoff targets such as operating status or network to which CMU200 is to switch, the required target parameters as for example channel number etc can be configured. This enables handoff to AMPS as well as handoff to and from the voice loopback mode

CDMA specifications – Mobile station test

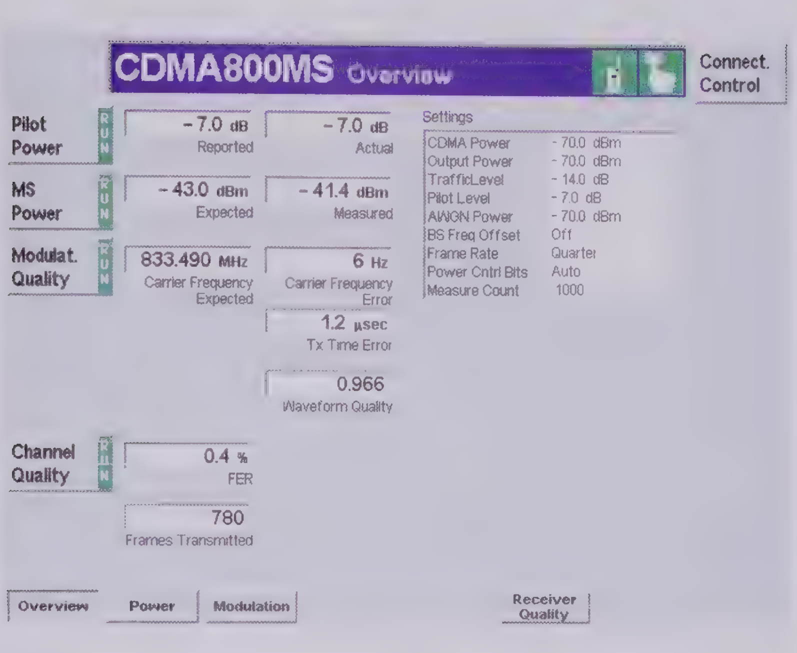
Standards	
CDMA standards	TIA/EIA-95, J-STD-008, ARIB T53, Korean, Chinese
CDMA test standards	TIA/EIA-98, J-STD-018

RF generator

Frequency range	
Option CMU-K81	
US Cellular	869 MHz to 894 MHz
China Cellular	934 MHz to 969 MHz
Japan Cellular	832 MHz to 870 MHz
Option CMU-K82	
PCS (US)	1930 MHz to 1990 MHz
PCS (Korea)	1805 MHz to 1870 MHz
Frequency resolution	channel spacing according to standard
Frequency uncertainty	same as time base
Output level range (modulated signal)	
RF1	–120 dBm to –33 dBm
RF2	–120 dBm to –16 dBm
RF3OUT	–80 dBm to +7 dBm
Output level resolution (modulated signal)	0.1 dB
Output level uncertainty	
RF1: ≥ –108 dBm	
in temperature range +23°C to +35°C	<0.5 dB
in temperature range +5°C to +45°C	<0.7 dB
RF2: ≥ –108 dBm	
in temperature range +23°C to +35°C	<0.5 dB
in temperature range +5°C to +45°C	<0.7 dB
RF3OUT: –80 dBm to +4 dBm	
in temperature range +23°C to +35°C	<0.7 dB
in temperature range +5°C to +45°C	<0.9 dB
Modulation	
QPSK, multiple QPSK	1.2288 Mcps
AWGN	see AWGN generator
Carrier suppression	>35 dB
Waveform quality factor (ρ)	>0.966; >0.995 typ.
AWGN generator	
Selectable bandwidth	1.23 MHz or 1.8 MHz
Output level resolution	0.1 dB

RF analyzer

Frequency range	
Option CMU-K81	
US Cellular	824 MHz to 849 MHz
China Cellular	889 MHz to 924 MHz
Japan Cellular	887 MHz to 925 MHz
Option CMU-K82	
PCS (US)	1850 MHz to 1910 MHz
PCS (Korea)	1715 MHz to 1780 MHz



Pilot Power: −7.0 dB Reported; −7.0 dB Actual
MS Power: −43.0 dBm Expected; −41.4 dBm Measured
Modulat. Quality: 833.490 MHz Carrier Frequency Expected; 6 Hz Carrier Frequency Error; 1.2 µsec Tx Time Error; 0.966 Waveform Quality
Channel Quality: 0.4 % FER; 780 Frames Transmitted

Settings
CDMA Power −70.0 dBm
Output Power −70.0 dBm
TrafficLevel −14.0 dB
Pilot Level −7.0 dB
AWGN Power −70.0 dBm
BS Freq Offset Off
Frame Rate Quarter
Power Cntrl Bits Auto
Measure Count 1000

The overview menu shows the most important parameters in a clear form. These include BS settings as well as MS test results such as power, frequency error and waveform quality. The overview menu also gives access to other test modules (power control, modulation, receiver quality)

Measurement filter	according to standard (1.23 MHz bandwidth)
Frequency resolution	channel spacing according to standard
Level range (O-QPSK signal)	
RF1	–40 dBm to +47 dBm
RF2	–54 dBm to +33 dBm
RF4IN	–80 dBm to –6 dBm

Power meter (frequency-selective)

Level uncertainty	
RF1, RF2, RF4IN	
in temperature range +23°C to +35°C	<0.5 dB
in temperature range +5°C to +45°C	<0.7 dB
Level resolution	0.1 dB

Modulation analyzer

ρ uncertainty (for ρ 0.9 to 1)	<0.003
Frequency measurement range	–3 kHz to +3 kHz
Frequency measurement uncertainty	≤30 Hz + drift of timebase
Timing measurement uncertainty	<60 ns

CDMA highlights of CMU200

Benefits of the base unit

- Platform, expandable for current and future standards (e.g. *Bluetooth*, cdma2000)
- See base unit section

CDMA-related features

- Voice loopback and comprehensive testing of mobiles
- Powerful signalling capabilities
- Built-in AWGN generator for simulating noise generated by other CDMA calls
- Base station simulation
- Mobile or base station originated call connect/disconnect
- Short measurement time ensuring high throughput
- Combined measurements (RX/TX in parallel)
- Benchmark-breaking IEEE-bus speed (see GSM highlights)
- Simple interactive operation, standardized MMI
- No specialized network knowledge required
- Various handoffs supported (e.g. CDMA to analog AMPS)
- Dual-band/dual-mode testing

All supported CDMA standards

Frequency band	Airlink standard
US Cellular (800 MHz)	TIA/EIA-IS-95
Japan Cellular	ARIB-T53/IS-95
China Cellular	TIA/EIA-IS-95
US PCS (1900 MHz)	ANSI-J-STD008, UB-IS-95
Korea PCS (1800 MHz)	J-STD008, UB-IS-95

Bluetooth™ measurements in CMU200

General

The CMU 200 with the *Bluetooth* option can set up a *Bluetooth* connection to a Device Under Test (DUT) via the RF interface. The CMU 200 switches the DUT into test mode and performs a number of basic RF measurements (TX and RX). According to the *Bluetooth* Test Mode Specification the DUT has to be locally enabled for the test mode operation. All measurements can be performed in hopping-, reduced hopping- or non-hopping-mode. The CMU 200 supports measurements using DH1, DH3 and DH5 packets.

The coupling between the CMU 200 and the DUT can be either via a cable or a coupler, depending on the implementation of the DUT.

Applications

The Universal Radio Communication Tester CMU 200 with the *Bluetooth* option is the ideal instrument for production, development and maintenance of any kind of devices with integrated *Bluetooth* wireless technology.

The CMU 200 can also be equipped with additional options for cellular standards like GSM, AMPS, TDMA or CDMA. Therefore the CMU 200 is an ideal tester for mobile phone production, as it offers measurements in line with *Bluetooth* wireless technology and cellular standards in one instrument. With a further extension, which is already in development, the CMU 200 will be able to run *Bluetooth* measurements and cellular measurements simultaneously. This means the total test time for a mobile phone will not be increased by the *Bluetooth* tests because the two types of tests can take place at the same time.

Compliance with existing Bluetooth standards

The CMU 200 is compliant with the *Bluetooth* core specification Ver. 1.0 B (Core specification Ver 1.1 in preparation). The *Bluetooth* Test Mode (Core Spec. Part I:1) is implemented with all commands needed to perform the TX/RX measurements.

The *Bluetooth* RF Test Specification Ver. 0.9 describes RF test cases for the *Bluetooth* qualification process. Rohde&Schwarz offers the Test System TS8960 for *Bluetooth* qualification tests, which is fully compliant with the RF Test Specification. Although the CMU 200 was not designed for qualification tests, the RF test specification was taken as a guideline for the implementation of the CMU 200´s *Bluetooth* measurements.

Signalling

Setting up a *Bluetooth* connection

The CMU 200 acts as the master of a *Bluetooth* piconet, the DUT as a slave. The CMU 200 is able to perform the inquiry procedure for the identification of all *Bluetooth* devices within range of the CMU 200. All devices found are listed on the display and one of them can be selected for the paging procedure. The CMU 200 then establishes the connection to the DUT and switches it into test mode operation.

The inquiry procedure can be skipped, if the *Bluetooth* device address of the DUT is already known. In this case a shorter setup time for the connection can be achieved. This is important for production tests of *Bluetooth* devices to increase the maximum throughput of a production line.

Signalling information from the DUT

The CMU 200 is able to display a variety of information which is received from the DUT (eg device name, version numbers, service class, supported features).

TX measurements

The current measurement values for each parameter are displayed on the CMU 200 screen. Additionally average, maximum and minimum values are displayed as a result of a statistical evaluation of a settable number of *Bluetooth* packets (bursts).

Power measurements

Measurement parameters:

Measurement parameters:
- Nominal power (measured as the part of the burst starting at the detected 1st bit of the preamble (bit 0) to the last bit of the burst)
- Leakage power (measured within defined areas before and after the burst)
  Peak power (shows the highest powerlevel within a burst)

Timing measurements

Measurement parameter:
- Packet alignment (distance between ideal master receiver slot and detected bit 0 of the received burst)

This measurement is displayed on the “Power” screen.

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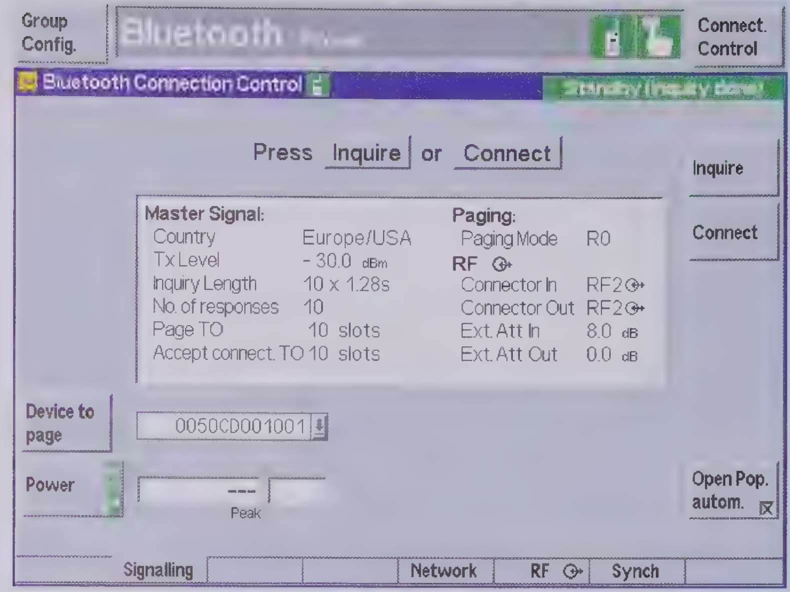
The connection control menu allows to inquire addresses of all Bluetooth devices in range. The "Device to page" softkey then selects the DUT for the measurements tests. Alternatively the input of a known address is possible


Group Config.
Bluetooth Power
Connect. Control
Bluetooth Connection Control
Standby (Inquiry done)
Inquire
Connect
Device to page
Power
Open Pop. autom. ☒
Signalling
Network
RF
Synch

Press Inquire or Connect

Master Signal:

Country	Europe/USA
Tx Level	- 30.0 dBm
Inquiry Length	10 x 1.28s
No. of responses	10
Page TO	10 slots
Accept connect. TO	10 slots

Paging:

Paging Mode	R0

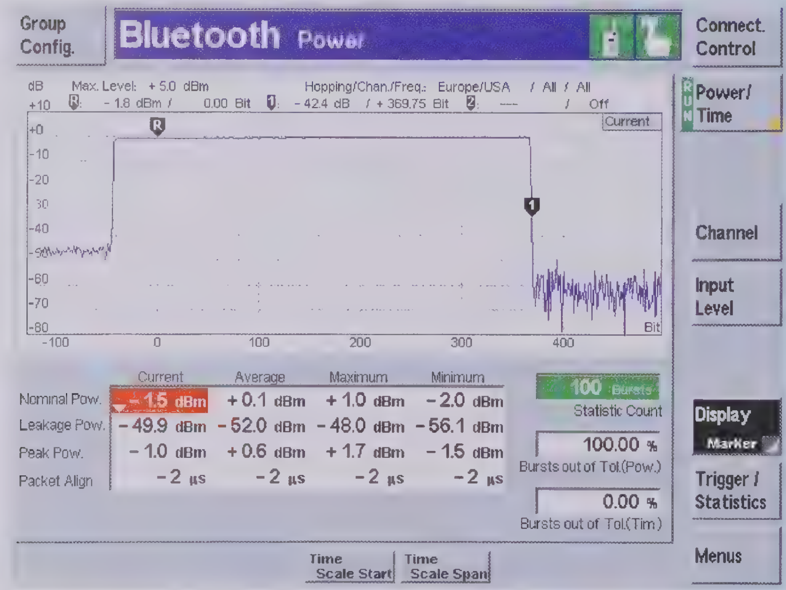
RF

Connector In	RF2
Connector Out	RF2
Ext. Att In	8.0 dB
Ext. Att Out	0.0 dB

Device to page: 0050CD001001

Power: --- Peak

The power menu shows the results in graphical and scalar form. Statistical functions as well as convenient markers aid further evaluation. The timing measurement complements the numerical power results


Group Config.
Bluetooth Power
Connect. Control
Power/ Time
Channel
Input Level
Display Marker
Trigger / Statistics
Menus
Time Scale Start
Time Scale Span
dB
+10
Current
+0
-10
-20
30
-40
-50
-60
-70
-80
-100
0
100
200
300
400
Bit
R
1

Max. Level: + 5.0 dBm Hopping/Chan./Freq.: Europe/USA / All / All

R: - 1.8 dBm / 0.00 Bit 1: - 42.4 dB / + 369.75 Bit 2: --- / Off

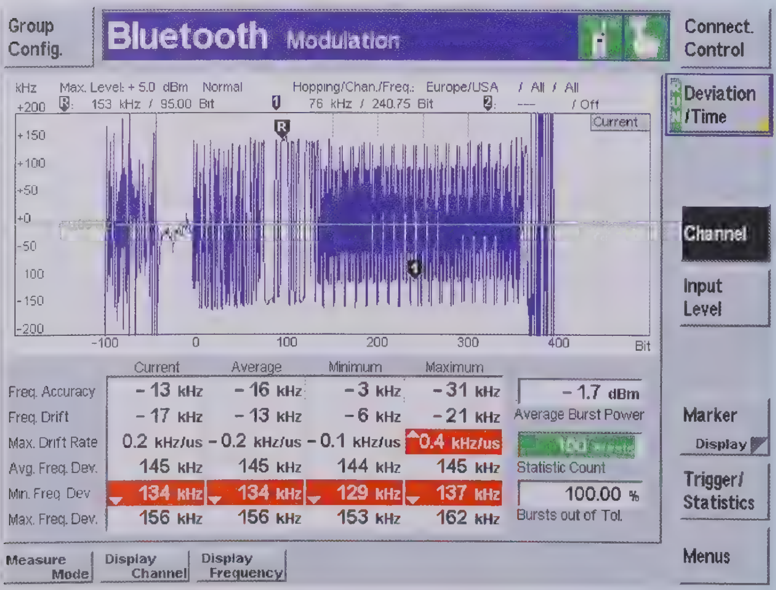
	Current	Average	Maximum	Minimum
Nominal Pow.	- 1.5 dBm	+ 0.1 dBm	+ 1.0 dBm	- 2.0 dBm
Leakage Pow.	- 49.9 dBm	- 52.0 dBm	- 48.0 dBm	- 56.1 dBm
Peak Pow.	- 1.0 dBm	+ 0.6 dBm	+ 1.7 dBm	- 1.5 dBm
Packet Align	- 2 µs	- 2 µs	- 2 µs	- 2 µs

100 Bursts Statistic Count

100.00 % Bursts out of Tol.(Pow.)

0.00 % Bursts out of Tol.(Tim.)

The graphical display of the modulation results may be spread between 1/1 and 1/8 of a burst for in-depth analysis. The "Max. Freq. Dev." and "Min Freq. Dev." results allow the highest and lowest values for 10 bit long fractions of a payload to be evaluated individually


Group Config.
Bluetooth Modulation
Connect. Control
Deviation /Time
Channel
Input Level
Marker Display
Trigger/ Statistics
Menus
Measure Mode
Display Channel
Display Frequency
kHz
+200
Current
+150
+100
+50
+0
-50
100
-150
-200
-100
0
100
200
300
400
Bit
R
1

Max. Level: + 5.0 dBm Normal Hopping/Chan./Freq.: Europe/USA / All / All

R: 153 kHz / 95.00 Bit 1: 76 kHz / 240.75 Bit 2: --- / Off

	Current	Average	Minimum	Maximum
Freq. Accuracy	- 13 kHz	- 16 kHz	- 3 kHz	- 31 kHz
Freq. Drift	- 17 kHz	- 13 kHz	- 6 kHz	- 21 kHz
Max. Drift Rate	0.2 kHz/us	- 0.2 kHz/us	- 0.1 kHz/us	0.4 kHz/us
Avg. Freq. Dev.	145 kHz	145 kHz	144 kHz	145 kHz
Min. Freq. Dev	134 kHz	134 kHz	129 kHz	137 kHz
Max. Freq. Dev.	156 kHz	156 kHz	153 kHz	162 kHz

- 1.7 dBm Average Burst Power

100 Bursts Statistic Count

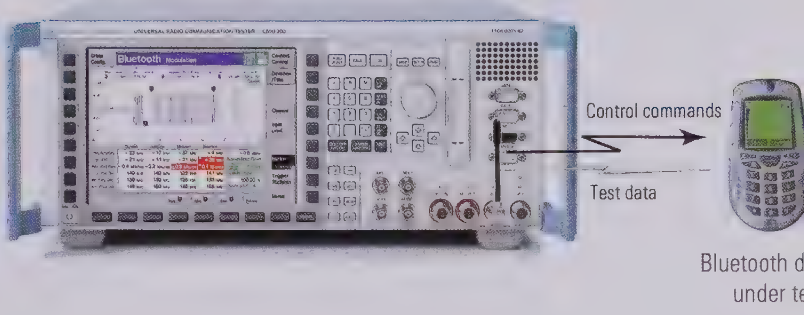
100.00 % Bursts out of Tol.

Bluetooth wireless technology in CMU200

Modulation measurements

Measurement parameters:

- Frequency accuracy (difference between measured frequency and intended transmitted frequency, measured in the preamble at the beginning of a packet)
- Frequency drift (difference between the frequency at the start of the packet and the frequency in the payload)
- Maximum drift rate (maximum drift rate anywhere within the packet payload)
- Average, maximum and minimum frequency deviation (calculated over the packet payload)



The device under test can be connected to the CMU200 via a RF coupler (antenna) or a cable

RX measurements

For RX measurements, the built-in signal generator generates a selectable bit sequence, which is looped back in the DUT and demodulated and processed by the CMU200 again. The TX level of the CMU200 can be adjusted for this measurement. The BER application supports defining up to five test programs. Each program can independently set settings such as control parameters, limits, repetition or statistical cycles.

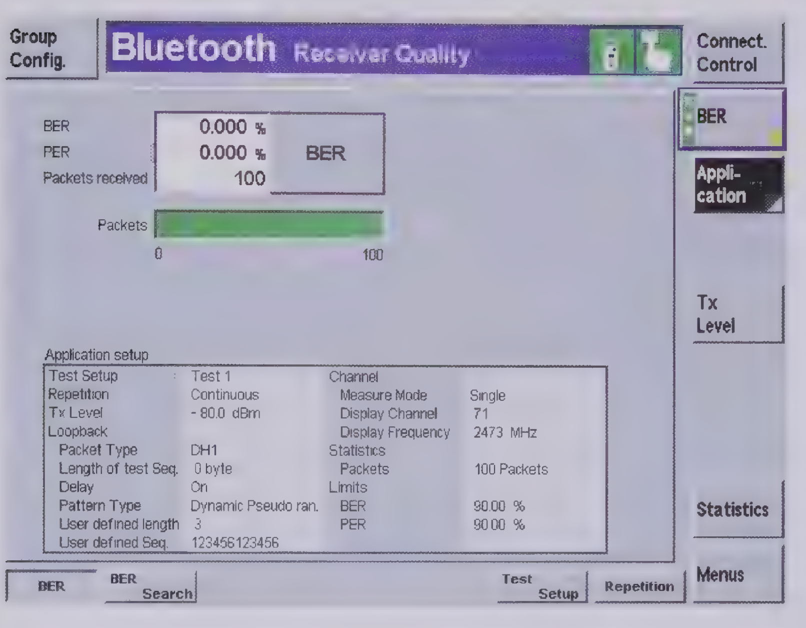
Bluetooth specifications

Standards	Bluetooth Specification Version 1.0 b

RF generator

Frequency range	
Europe (except Spain and France), USA and Japan	2.4000 GHz to 2.4835 GHz
France	2.4465 GHz to 2.4835 GHz
Spain	2.4450 GHz to 2.475 GHz
Frequency resolution	channel spacing 1 MHz according to standard
Frequency hopping	all modes according to standard
Output level range (modulated signal)	
RF1	–106 dBm to –33 dBm
RF2	–106 dBm to –12 dBm
RF3OUT	–90 dBm to +5 dBm
Output level resolution	0.1 dB

Output level uncertainty	
RF1	
in temperature range +23°C to +35°C	<0.9 dB
in temperature range +5°C to +45°C	<1.6 dB
RF2	
in temperature range +23°C to +35°C	<0.9 dB
in temperature range +5°C to +45°C	<1.6 dB
RF3OUT	
in temperature range +23°C to +35°C	<1.1 dB
in temperature range +5°C to +45°C	<1.6 dB
Modulation	
GFSK	
(AC coupling cut off frequency 100Hz)	1 Mbps, B*T=0.5
Modulation index (1111000 pattern in temperature range +23°C to +35°C)	0.304 to 0.336 plus residual FM (see base unit)



BER 0.000 %
PER 0.000 %
Packets received 100

Application setup

Test Setup	Test 1	Channel	
Repetition	Continuous	Measure Mode	Single
Tx Level	- 80.0 dBm	Display Channel	71
Loopback		Display Frequency	2473 MHz
Packet Type	DH1	Statistics	
Length of test Seq.	0 byte	Packets	100 Packets
Delay	On	Limits	
Pattern Type	Dynamic Pseudo ran.	BER	90.00 %
User defined length	3	PER	90.00 %
User defined Seq.	123456123456		

The receiver quality measurement includes output of BER and PER values. Supports three modes, single shot, continuous and search of a target BER value by automatic variation of CMU 200 output level. Up to 5 different best scenarios can be configured.

Sensitivity

Measurement parameters

- BER (percentage of bit errors that have occurred within the current statistical cycle)
- PER (percentage of packet errors that have occurred within the current statistical cycle, where an errored packet is a packet with a header which cannot be corrected)

Bluetooth wireless technology highlights of CMU200

- *Bluetooth* test mode signalling
- High measurement accuracy and speed
- Parallel TX and RX measurement of the RF interface in loopback mode
- Output of *Bluetooth* specific clock signal
- IF signal output
- Graphical and scalar result output

Supported Standards

- *Bluetooth* Specification Version 1.0 b (prepared for Version 1.1)

RF analyzer

Frequency range	
Europe (except Spain and France), USA and Japan	2.4000 GHz to 2.4835 GHz
France	2.4465 GHz to 2.4835 GHz
Spain	2.4450 GHz to 2.475 GHz
Frequency resolution	channel spacing 1 MHz according to standard
Frequency hopping	all modes according to standard

Power meter (frequency selective) and power versus time

Level Resolution	0.1 dB
Reference level for full dynamic range (GFSK signal)	
RF1	0 dBm to +41 dBm
RF2	–14 dBm to +33 dBm
RF4IN	–32 dBm to 0 dBm
Level uncertainty from full scale down to –25 dB	
RF1, RF2	
in temperature range +23°C to +35°C	<0.7 dB
in temperature range +5°C to +45°C	<1.0 dB
RF4IN	
in temperature range +23°C to +35°C	<0.9 dB
in temperature range +5°C to +45°C	<1.1 dB
Dynamic range	>55 dB (BW= 3 MHz, rms)

Modulation analyzer (BW= 3 MHz)

Level range (GFSK signal)	
RF1, RF2, RF4IN	from full–scale setting down to –25 dB
Frequency offset error in preamble	≤4 kHz
Frequency deviation error in payload (for deviation ≤200 kHz)	≤5.5%
Total measurement range for frequency offset and frequency deviation	–250 kHz to +250 kHz

Timing measurement

Range	±20 µs
Uncertainty	≤0.25 µs

Base unit specifications

Please see standard-specific data on the previous pages for more details and improved accuracy

Timebase TCXO

Max. frequency drift	
in temperature range +5 °C to +45 °C	±1 x 10^{-6}
Max. aging	±1 x 10^{-6}/year

Timebase OCXO – option CMU-B11

Max. frequency drift	
in temperature range +5 °C to+45 °C	±1 x 10^{-7}
Max. aging	±2 x 10^{-7}/year, ±5 x 10^{-9}/day after 30 days of operation
Warmup time (at +25 °C)	approx. 5 min

Timebase OCXO – option CMU-B12

Max. frequency drift	
in temperature range +5 °C to +45 °C	±5 x 10^{-9}, referred to +25 °C
with instrument orientation	±3 x 10^{-9}
referred to turn-off frequency after 2 h warmup time following a 24 h off time at +25 °C	±5 x 10^{-9}
Max. aging	±3.5 x 10^{-8}/year, ±5 x 10^{-10}/day after 30 days of operation
Warmup time (at +25 °C)	approx. 10 min

Reference frequency inputs/outputs

Synchronization input	BNC connector REFIN
Frequency	
Sinewave	1 MHz to 52 MHz, step 1 kHz
Squarewave (TTL level)	10 kHz to 52 MHz, step 1 kHz
Max. frequency variation	±5 x 10^{-6}
Input voltage range	0.5 V to 2 V, rms
Impedance	50 Ω
Synchronization output 1	BNC connector REFOUT1
Frequency	10 MHz from internal reference or frequency at synchronization input
Output voltage	>1.4 V, peak-peak
Impedance	50 Ω
Synchronization output 2	BNC connector REFOUT2
Frequency	net-specific frequencies in range 100 kHz to 40 MHz
Output voltage (f ≤13 MHz)	>1.0 V, peak-peak
Impedance	50 Ω

RF generator

Frequency range	100 kHz to 2700 MHz
Frequency resolution	0.1 Hz
Frequency uncertainty	same as timebase + resolution
Frequency settling time	<400 µs to Δf <1kHz

Output level range

RF1	
100 kHz to 2200 MHz	–130 dBm to –27 dBm
2200 MHz to 2700 MHz	–130 dBm to –33 dBm
RF2	
100 kHz to 2200 MHz	–130 dBm to –10 dBm
2200 MHz to 2700 MHz	–130 dBm to –16 dBm
RF3OUT	
100 kHz to 2200 MHz	–90 dBm to +13 dBm
2200 MHz to 2700 MHz	–90 dBm to +5 dBm

Output level uncertainty

RF1, RF2			
in temperature range +23 °C to +35°C	**≥–106 dBm**	**>–117 dBm**	**–117 to –130 dBm**
10 MHz to 450 MHz	<0.6 dB		
450 MHz to 2200 MHz	<0.6 dB	<0.6 dB[2]	<1.5 dB[1][2]
2200 MHz to 2700 MHz	<0.8 dB	<0.8 dB[2]	<1.5 dB[1][2]
in temperature range +5 °C to +45 °C	**≥–106 dBm**	**>–117 dBm**	**–117 to –130 dBm**
10 MHz to 450 MHz	<1.0 dB		
450 MHz to 2200 MHz	<1.0 dB	<1.0 dB[2]	<1.5 dB[1][2]
2200 MHz to 2700 MHz	<1.5 dB	<1.5 dB[2]	<1.5 dB[1][2]

RF3OUT	
in temperature range +23 °C to +35 °C	
10 MHz to 450 MHz: –80 dBm to +10 dBm	<0.8 dB
450 MHz to 2200 MHz: –90 dBm to +10 dBm	<0.8 dB
2200 MHz to 2700 MHz: –90 dBm to +5 dBm	<1.0 dB
RF3OUT in temperature range +5 °C to +45 °C	
10 MHz to 450 MHz: –80 dBm to +10 dBm	<1.0 dB
450 MHz to 2200 MHz: –90 dBm to +10 dBm	<1.0 dB
2200 MHz to 2700 MHz: –90 dBm to +5 dBm	<1.5 dB

Output level settling time	<4 µs
Output level resolution	0.1 dB

Generator RF level repeatability

(RF1, RF2, RF3OUT, typical values after 1h warm-up)

Output ≥–80 dBm	<0.01 dB
Output <–80 dBm	<0.1 dB

VSWR

RF1	
10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6
RF2	
10 MHz to 2200 MHz	<1.2
2200 MHz to 2700 MHz	<1.6
RF3OUT	
10 MHz to 2200 MHz	<1.5
2200 MHz to 2700 MHz	<1.7

Attenuation of harmonics (f_0 = 10 MHz to 2200 MHz, up to 7 GHz)	
RF1, RF2	>30 dB
RF3OUT (P≤ +10 dBm)	>20 dB
Attenuation of nonharmonics	
10 MHz to 2200 MHz at >5 kHz from carrier	>40 dB

Phase noise (single sideband, f < 2.2 GHz)	
Carrier offset	
20 kHz to 250 kHz	<–100 dBc(1 Hz)
≥250 kHz	<–110 dBc(1 Hz)
Residual FM	
30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)
Residual AM	
CCITT	<0.02% (rms)

IQ modulation

Data for frequency offset range 0 kHz to ±135 kHz

Carrier suppression	>40 dB

RF analyzer

VSWR

RF1	
10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6
RF2	
10 MHz to 2200 MHz	<1.2
2200 MHz to 2700 MHz	<1.6
RF4IN	
10 MHz to 2200 MHz	<1.5
2200 MHz to 2700 MHz	<1.6

Power meter (wideband)

Frequency range	100 kHz to 2700 MHz

Level range

RF1	
continuous power[3]	
100 kHz to 2200 MHz	+6 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	+10 dBm to +47 dBm (50 W)
Peak Envelope Power [4] (PEP)	+53 dBm (200 W)
RF2	
continuous power	
100 kHz to 2200 MHz	–8 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–4 dBm to +33 dBm
Peak Envelope Power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
100 kHz to 2200 MHz	–33 dBm to 0 dBm
2200 MHz to 2700 MHz	–29 dBm to 0 dBm

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[1] Valid for RF1 only.

[2] Not valid at frequencies of netclock harmonics

[3] 50 W in temperature range +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.

[4] Mean value of power vs time must be equal or less than allowed continuous power.

Level uncertainty

RF1	+10 dBm to +20 dBm	+20 dBm to +47 dBm
50 MHz to 2700 MHz	<1.0 dB[6]	<0.5 dB[5] [6]
RF2	–4 dBm to +6 dBm	+6 dBm to +33 dBm
50 MHz to 2700 MHz	<1.0 dB[6]	<0.5 dB[6]
RF4IN	–29 dBm to –19dBm	–19 dBm to 0 dBm
50 MHz to 2700 MHz	<1.5 dB	<0.8 dB

Level resolution	0.1 dB (0.01 dB via remote control)

Power meter (frequency-selective)

Frequency range	10 MHz to 2700 MHz
Frequency resolution	0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps

Level range

RF1	
continuous power[3]	
10 MHz to 2200 MHz	–40 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	–34 dBm to +47 dBm (50 W)
Peak Envelope Power [4] (PEP)	+53 dBm (200 W)
RF2	
continuous power	
10 MHz to 2200 MHz	–54 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–48 dBm to +33 dBm
Peak Envelope Power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
10 MHz to 2200 MHz	–80 dBm to 0 dBm
2200 MHz to 2700 MHz	–74 dBm to 0 dBm

Level uncertainty

RF1, RF2	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.5 dB
2200 MHz to 2700 MHz	<0.7 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.0 dB
RF4IN	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.7 dB
2200 MHz to 2700 MHz	<0.9 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.1 dB

Level resolution	0.1 dB (0.01 dB via remote control)

RF level measurement repeatability
(RF1, RF2, RF4IN, typical values after 1h warm-up)

Input ≥ –40 dBm	<0.01 dB
Input < –40 dBm	<0.03 dB

Demodulation (data of hardware paths)

Phase noise (single sideband, f <2.2 GHz)

Carrier offset	
20 kHz to 250 kHz	<–100 dBc(1 Hz)
250 kHz to 400 kHz	<–110 dBc(1 Hz)
≥400 kHz	<–118 dBc(1 Hz)

Residual FM

30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)

Residual AM

CCITT	<0.02% (rms)

Spectrum analyzer

Frequency range	10 MHz to 2.7 GHz
Span	zero span to full span
Frequency resolution	0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps
Sweep time	≥100 ms, depending on RBW
Display	560 dots, horizontal
Marker	up to 3, absolute/relative
Display line	1
Display scale	10/20/30/50/80/100 dB

Level range

RF1	
continuous power[3]	up to +47 dBm (50 W)
max. peak power[4] (PEP)	up to +53 dBm (200 W)
RF2	
continuous power	up to +33 dBm (2 W)
max. peak power[4] (PEP)	up to +39 dBm (8 W)
RF4IN (continuous power and PEP)	up to 0 dBm

Level uncertainty

RF1, RF2	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.5 dB
2200 MHz to 2700 MHz	<0.7 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.0 dB
RF4IN	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.7 dB
2200 MHz to 2700 MHz	<0.9 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.1 dB

Reference level for full dynamic range (low noise mode)

Logarithmic level display	
RF1	+10 dBm to +47 dBm
RF2	–4 dBm to +33 dBm
RF4IN	–22 dBm to 0 dBm

Displayed average noise level (RBW 1 kHz, low noise mode)

RF1/RF2/RF4IN	
10 MHz to 2200 MHz	<–100 dBc
2200 MHz to 2700 MHz	<–95 dBc

Inherent spurious response	<–50 dB

Low distortion mode, 20 MHz to 2200 MHz, except 1816.115 MHz

Inherent harmonics
(f_0 = 50 MHz to 2200 MHz, up to 7 GHz)

RF1, RF2	<–30 dB
RF4IN	<–20 dB

Audio option CMU-B41

AF generator

Output impedance	<4 Ω
Maximum output current	20 mA

AF sine generator

Frequency range	20 Hz to 20 kHz
Frequency uncertainty	same as time base + half resolution
Frequency resolution	0.1 Hz
Output level range	10 µV to 5 V
Output level resolution	
at level <10 mV	10 µV
at level ≥10 mV	0.1%
Output level uncertainty	
at level ≥1 mV and frequency ≤10 kHz	≤1.5% + resolution
THD+N[7]	
at level ≥100 mV into load ≥600 Ω	≤0.05%
THD[7]	
at level ≥100 mV into load ≥600 Ω	≤0.025%

AF analyzer

Input impedance	1MΩ || 100 pF

AF voltmeter

Frequency range	50 Hz to 20 kHz
Level Range	50 µV to 30 V
Level Resolution	
at level <1 mV	1 µV
at level ≥1 mV	0.1%
Level uncertainty	
at 1 mV ≤level≤ 2 V	<1.0% + resolution
at 2 V <level≤20 V	<2.0% + resolution

---

[5] Calibrated for P>33 dBm only in frequency range 800 MHz to 2000 MHz.

[6] Temperature range +5° C to +23 °C or +35 °C to +45 °C and f>2200 MHz: add 0.2 dB.

[7] Measurement bandwidth: 21.9 kHz

THD+N meter	
Measurement bandwidth	21 kHz
Frequency range	100 Hz to 10 kHz
Level Range	10 mV to 30 V
Resolution	0.01% THD+N
Inherent distortion	
at 100 mV ≤ level≤ 20 V	<0.05% THD+N
Uncertainty	
at 100 mV ≤ level≤ 2 V	<1% + inherent distortion
at 2 V <level≤20 V	<2% + inherent distortion

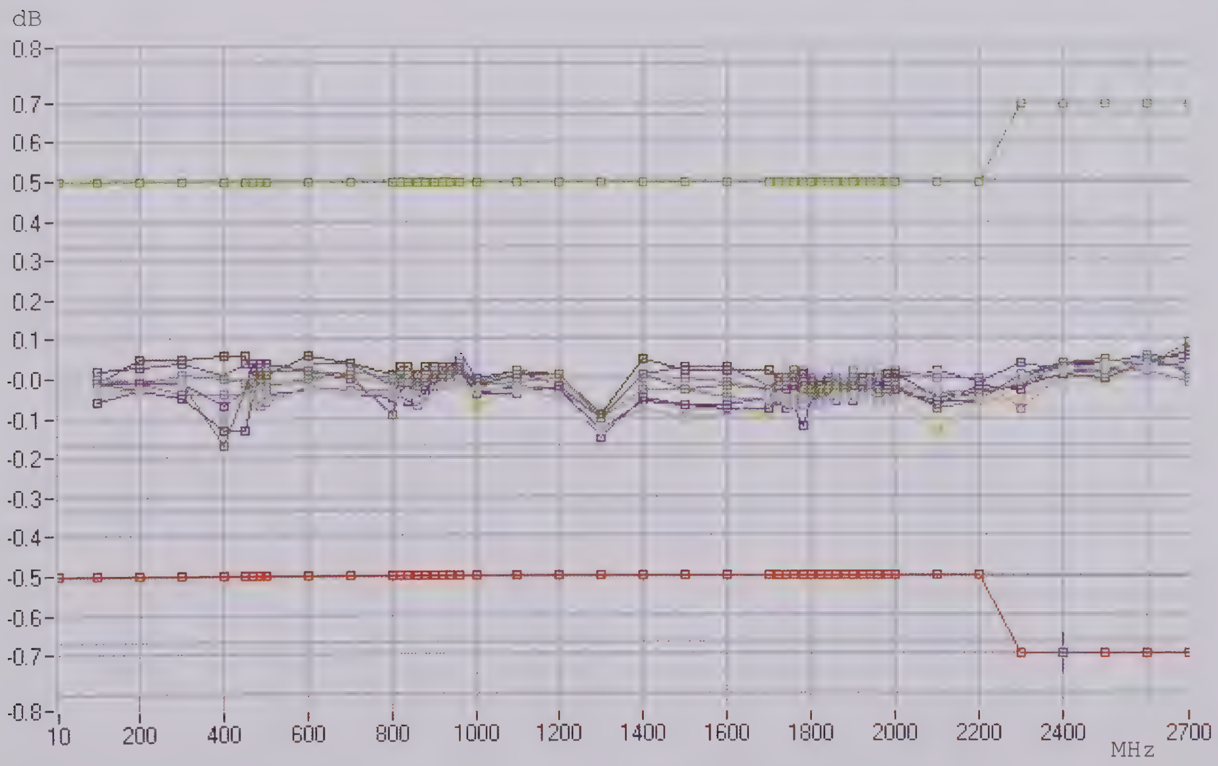
General data

Rated temperature range	+5 °C to +45 °C
Storage temperature range	–25 °C to +60 °C
Humidity	+40 °C, 80% rh, non-condensing; complies with IEC 68-2-3
Display	21 cm TFT color display (8.4")
Resolution	640 x 480 pixels (VGA resolution)
Pixel failure rate	<2 x 10^{-5}
Electromagnetic compatibility	meets requirements of EMC Directive 89/336/EEC (EN50081-1 and EN50082-2)
Mechanical resistance (non operating mode)	
Vibration, sinusoidal	meets IEC68-2-6, IEC1010-1, EN61010-1, MIL-T-28800 D class 5, 5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g const.
Vibration, random	meets DIN IEC 68-2-36, DIN 40046 T24 10 Hz to 300 Hz, acceleration 1.2 g rms
Shock	meets DIN IEC 68-2-27, MIL-STD-810D 40 g shock spectrum
Electrical safety	IEC1010-1, DIN EN61010-1, UL3111-1, CSA22.2 No. 1010-1
Power supply	100 V to 240 V ± 10% (AC), 3.1 A to 1.3 A, 50 Hz to 400 Hz –5% to +10% power factor correction, EN61000-3-2

Power consumption	
Base unit	130 W
With typical options	180 W
Dimensions (W x H x D)	465 mm x 193 mm x 517 mm (19"; 4 height units)
Weight	
Base unit	14 kg
With typical options	18 kg

Inputs and outputs (rear panel)

IF3 RX CH1	Z_{out} = 50 Ω, BNC female, max level –2 dBm, 10.7 MHz
IEC/IEEE-bus remote control interface to IEC 625-2 (IEEE 488.2)	
Connector	24-pin Amphenol
Serial interface COM1, COM2	RS 232 C (COM), 9-pin sub-D connector
Printer interface LPT	parallel (Centronics-compatible)
Keyboard connector	PS/2
Connector for ext. monitor (VGA)	15-pin sub-D connector



Rohde&Schwarz specifications are a conservative view of what a product has to offer. As an example, this diagram presents the accuracy of the CMU200 frequency selective power measurement. This is shown here for 10 randomly chosen instruments at 25°C and 0 dBm on RF2 without taking additional measurement uncertainty rom the test system itself into account. The tolerances marked above and below (green and red line) indicate the data stated in this data sheet´s general data section.

Models and options

Instruments, options and ordering information

Type/Option	Description	GSM	TDMA	AMPS	CDMA	Bluetooth	Order number
CMU200	Base unit with following accessories: power cord, operating manual, service manual instrument	✓	✓	✓	✓	✓	1100.0008.02
CMU-B11[1]	Reference OCXO, aging 2 x 10^{-7}/year. Ensures high absolute accuracy, minimum temperature-dependent drift and especially high long-term stability. Used for measurements with exact frequency stability requirements	☺	☺	☺	☺	☺	1100.5000.02
CMU-B12[1]	High-stability OCXO, aging 3.5 x 10^{-8}/year. Oven crystal with highest long-term stability. Ensures compliance with tolerances specified by GSM. Used for highly demanding frequency stability requirements to GSM 11.20	☺	☺	☺	☺	☺	1100.5100.02
CMU-B21	Versatile signalling unit. Provides multistandard signalling hardware	✓	✓	✓	–	✓	1100.5200.02
CMU-B41	Audio generator and analyzer. Includes audio frequency (AF) generator, voltmeter, distortion meter	☺	☺	✓	–	–	1100.5300.02
CMU-B52[2]	Internal versatile multimode speech coder/decoder. This option converts digital speech signals into analog signals and vice versa. The option allows separate uplink and downlink audio application measurements on mobile phones.	☺	☺	–	–	–	1100.5400.02
CMU-B53[2]	Bluetooth extension, factory installation only	–	–	–	–	✓	1100.5700.02
CMU-B81	cdmaOne signalling unit	–	–	–	✓	–	1100.6506.02
CMU-U53[2]	Bluetooth upgrade kit for CMU	–	–	–	–	✓[7]	1100.7302.02
CMU-U61	Modification kit: floppy disk drive 3 ½" instead of PCMCIA	☺	☺	☺	☺	☺	1100.5500.02
CMU-K20[2]	GSM400 mobile station signalling/non-signalling test	✓[8]	–	–	–	–	1115.5900.02
CMU-K21[2]	GSM900, R-GSM and E-GSM mobile station signalling/non-signalling test	✓[8]	–	–	–	–	1115.6007.02
CMU-K22[2]	GSM1800 (DCS) mobile station signalling/non-signalling test	✓[8]	–	–	–	–	1115.6107.02
CMU-K23[2]	GSM1900 (PCS) mobile station signalling/non-signalling test	✓[8]	–	–	–	–	1115.6207.02
CMU-K24[2]	GSM850 mobile station signalling/non-signalling test	✓[8]	–	–	–	–	1115.6307.02
CMU-K27[2]	IS-136/Cellular (800 MHz band) mobile station signalling/non-signalling test	–	✓[8]	–	–	–	1115.6607.02
CMU-K28[2]	IS-136/Cellular (1900 MHz band) mobile station signalling/non- signalling test	–	✓[8]	–	–	–	1115.6707.02
CMU-K29[3]	AMPS mobile station signalling/non-signalling test	–	–	✓	–	–	1115.6807.02
CMU-K53[2][5]	Bluetooth test software	–	–	–	–	✓	1115.5000.02
CMU-K81[4]	CDMA 800 mobile station signalling/non-signalling test	–	–	–	✓[8]	–	1115.5500.02
CMU-K82[4]	CDMA 1700/1900 mobile station signalling/non-signalling test	–	–	–	✓[8]	–	1115.5600.02
BWR-C1	Corner cover 1 (2 pieces required)	–	–	–	–	–	1096.2593.00
BWR-C2	Corner cover 2 (2 pieces required)	–	–	–	–	–	1096.2602.00
CMU-DCV	Documentation of calibration values	☺	☺	☺	☺	☺	0240.2193.08
CRT-Z2	GSM/GPRS test SIM for loopback mode, required for BER and other applications	☺	–	–	–	–	1039.9005.02
CMU-Z1	30 MB memory card for use with PCMCIA interface	☺	☺	☺	☺	☺	1100.7490.02
PSM-B9	PCMCIA Type 3, 520 MB hard disk	☺	☺	☺	☺	☺	1064.5700.02
ZAA-411	19" rack adapter	☺	☺	☺	☺	☺	1096.3283.00

Comments on table:

✓ mandatory; ☺ optional; – not applicable

[1] CMU-B11 or CMU-B12 possible. One of two OCXOs should be installed to ensure high frequency accuracy or external frequency reference may be used, if available.

[2] CMU-B21 necessary.

[3] CMU-B21 and CMU-B41 necessary

[4] CMU-B81 necessary.

[5] CMU-B53 necessary.

[6] CMU-K53 necessary.

[7] For upgrade only if factory installation is not applicable. Includes CMU-B53 and CMU-K53.

[8] Depending on the required frequency band.

ROHDE&SCHWARZ

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WCDMA
GPRS
EDGE
GSM

Universal Radio Communication Tester CMU300

ROHDE & SCHWARZ

Timebase TCXO

Max. frequency drift	
in temperature range	
+5 °C to +45 °C	±1 x 10^{-6}
Max. aging	±1 x 10^{-6}/year

Timebase OCXO – option CMU-B12

Max. frequency drift	
in temperature range	
+5 °C to +45 °C	±5 x 10^{-9}, referred to +25 °C
with instrument orientation	±3 x 10^{-9}
referred to turn-off frequency after 2 h warmup time following a 24 h off time at +25 °C	±5 x 10^{-9}
Max. aging	±3.5 x 10^{-8}/year, ±5 x 10^{-10}/day after 30 days of operation
Warmup time (at +25 °C)	approx. 10 min

Reference frequency inputs/outputs

Synchronization input	BNC connector REFIN
Frequency	
Sinewave	1 MHz to 52 MHz, step 1 kHz
Squarewave (TTL level)	10 kHz to 52 MHz, step 1 kHz
Max. frequency variation	±5 x 10^{-6}
Input voltage range	0.5 V to 2 V, rms
Impedance	50 Ω
Synchronization output 1	BNC connector REFOUT1
Frequency	10 MHz from internal reference or frequency at synchronization input
Output voltage	>1.4 V, peak-peak
Impedance	50 Ω
Synchronization output 2	BNC connector REFOUT2
Frequency	net-specific frequencies in range 100 kHz to 40 MHz
Output voltage (f ≤13 MHz)	>1.0 V, peak-peak
Impedance	50 Ω

Frequency range	100 kHz to 2700 MHz
Frequency resolution	0.1 Hz
Frequency uncertainty	same as timebase + resolution
Frequency settling time	<400 µs to Δf <1kHz

Output level range

RF1	
100 kHz to 2200 MHz	–130 dBm to –27 dBm
2200 MHz to 2700MHz	–130 dBm to –33 dBm
RF2	
100 kHz to 2200 MHz	–130 dBm to –10 dBm
2200 MHz to 2700MHz	–130 dBm to –16 dBm
RF3OUT	
100 kHz to 2200 MHz	–90 dBm to +13 dBm
2200 MHz to 2700MHz	–90 dBm to +5 dBm

Output level uncertainty

RF1, RF2 (temperature range +23 °C to +35 °C)

	≥–106 dBm	**>–117 dBm**	**–117 to –130dBm**
10 MHz to 450 MHz	<0.6 dB		
450 MHz to 2200 MHz	<0.6 dB	<0.6 dB[2]	<1.5 dB[1][2]
2200 MHz to 2700 MHz	<0.8 dB	<0.8 dB[2]	<1.5 dB[1][2]

RF1, RF2 (temperature range +5 °C to +45 °C)

	≥–106 dBm	**>–117 dBm**	**–117 to –130 dBm**
10 MHz to 450 MHz	<1.0 dB		
450 MHz to 2200 MHz	<1.0 dB	<1.0 dB[2]	<1.5 dB[1][2]
2200 MHz to 2700 MHz	<1.5 dB	<1.5 dB[2]	<1.5 dB[1][2]

RF3OUT (temperature range +23 °C to +35 °C)	
10 MHz to 450 MHz	<0.8 dB P=–80 dBm to +10 dBm
450 MHz to 2200 MHz	<0.8 dB P=–90 dBm to +10 dBm
2200 MHz to 2700 MHz	<1.0 dB P=–90 dBm to +5 dBm
RF3OUT (temperature range +5 °C to +45 °C	
10 MHz to 450 MHz	<1.0 dB P=–80 dBm to +10 dBm
450 MHz to 2200 MHz	<1.0 dB P=–90 dBm to +10 dBm
2200 MHz to 2700 MHz	<1.5 dB P=–90 dBm to +5 dBm

Output level settling time	<4 µs

Output level resolution	0.1 dB

Generator RF level repeatability

(RF1, RF2, RF3OUT, typical values after 1h warm-up):

Output ≥–80 dBm	<0.01 dB
Output <–80 dBm	<0.1 dB

VSWR

RF1	
10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6
RF2	
10 MHz to 2200 MHz	<1.2
2200 MHz to 2700 MHz	<1.6
RF3OUT	
10 MHz to 2200 MHz	<1.5
2200 MHz to 2700 MHz	<1.7

Attenuation of harmonics (f_0 = 10 MHz to 2200 MHz, up to 7 GHz)

RF1, RF2	>30 dB
RF3OUT (P≤ +10 dBm)	>20 dB

Attenuation of nonharmonics

10 MHz to 2200 MHz	>40 dB at >5 kHz from carrier

Spectral purity

Phase noise (single sideband, f < 2.2 GHz)	
Carrier offset	
20 kHz to 250 kHz	<–100 dBc(1 Hz)
≥250 kHz	<–110 dBc(1 Hz)
Residual FM	
30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)
Residual AM	
CCITT	<0.02% (rms)

IQ modulation

Data for frequency offset range 0 kHz to ±135 kHz

Carrier suppression	>40 dB

VSWR

RF1	
10 MHz to 2000 MHz	<1 2
2000 MHz to 2200 MHz	<1 3
2200 MHz to 2700 MHz	<1.6
RF2	
10 MHz to 2200 MHz	<1 2
2200 MHz to 2700 MHz	<1 6
RF4IN	
10 MHz to 2200 MHz	<1 5
2200 MHz to 2700 MHz	<1.6

Power meter (wideband)

Frequency range	100 kHz to 2700 MHz

Level range

RF1	
continuous power[3]	
100 kHz to 2200 MHz	+6 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	+10 dBm to +47 dBm (50 W)
Peak Envelope Power [4] (PEP)	+53 dBm (200 W)
RF2	
continuous power	
100 kHz to 2200 MHz	–8 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–4 dBm to +33 dBm
Peak Envelope Power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
100 kHz to 2200 MHz	–33 dBm to 0 dBm
2200 MHz to 2700 MHz	–29 dBm to 0 dBm

Level uncertainty

RF1	10 dBm to 20 dBm	20 dBm to 47 dBm
50 MHz to 2700 MHz	<1.0 dB[6]	<0.5 dB[5] [6]
RF2	–4 dBm to +6 dBm	+6 dBm to +33 dBm
50 MHz to 2700 MHz	<1.0 dB[6]	<0.5 dB[6]
RF4IN	–29 dBm to –19dBm	–19 dBm to 0 dBm
50 MHz to 2700 MHz	<1.5 dB	<0.8 dB
Level resolution	0.1 dB	

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[1] Valid for RF1 only.

[2] Not valid at frequencies of netclock harmonics.

[3] 50 W in temperature range +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.

[4] Mean value of power vs time must be equal or less than allowed continuous power.

[5] Calibrated for P>33 dBm only in frequency range 800 MHz to 2000 MHz.

[6] Temperature range +5° C to +23 °C or +35 °C to +45 °C and f>2200 MHz: add 0.2 dB.

Power meter (frequency-selective)

Frequency range	10 MHz to 2700 MHz
Frequency resolution	0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps

Level range

RF1	
continuous power[3]	
10 MHz to 2200 MHz	–40 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	–34 dBm to +47 dBm (50 W)
Peak Envelope Power [4] (PEP)	+53 dBm (200 W)
RF2	
continuous power	
10 MHz to 2200 MHz	–54 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–48 dBm to +33 dBm
Peak Envelope Power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
10 MHz to 2200 MHz	–80 dBm to 0 dBm
2200 MHz to 2700 MHz	–74 dBm to 0 dBm

Level uncertainty

RF1, RF2	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.5 dB
2200 MHz to 2700 MHz	<0.7 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.0 dB
RF4IN	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.7 dB
2200 MHz to 2700 MHz	<0.9 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.1 dB

RF level measurement repeatability

(RF1, RF2, RF4IN, typical values after 1h warm-up):

Input ≥–40 dBm	<0.01 dB
Input <–40 dBm	<0.03 dB

Level resolution	0.1 dB

Demodulation (data of hardware paths)

Spectral purity

Phase noise (single sideband, f <2.2 GHz)	
Carrier offset	
20 kHz to 250 kHz	<–100 dBc(1 Hz)
250 kHz to 400 kHz	<–110 dBc(1 Hz)
≥400 kHz	<–118 dBc(1 Hz)
Residual FM	
30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)
Residual AM	
CCITT	<0.02% (rms)

Frequency range	10 MHz to 2.7 GHz
Span	zero span to full span
Frequency resolution	0.1 Hz
Resolution bandwidths	10 Hz to 1 MHz in 1/2/3/5 steps
Sweep time	≥100 ms, depending on RBW
Display	560 dots, horizontal
Marker	up to 3, absolute/relative
Display line	1
Display scale	10/20/30/50/80/100 dB

Level range

RF1	
continuous power[3]	up to +47 dBm (50 W)
max. peak power[4] (PEP)	up to +53 dBm (200 W)
RF2	
continuous power	up to +33 dBm (2 W)
max. peak power[4] (PEP)	up to +39 dBm (8 W)
RF4IN (continuous power and PEP)	up to 0 dBm

Level uncertainty

RF1, RF2	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.5 dB
2200 MHz to 2700 MHz	<0.7 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.0 dB
RF4IN	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.7 dB
2200 MHz to 2700 MHz	<0.9 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.1 dB

Reference level for full dynamic range (low noise mode)

Logarithmic level display	
RF1	+10 dBm to +47 dBm
RF2	–4 dBm to +33 dBm
RF4IN	–22 dBm to 0 dBm

Displayed average noise level (RBW 1 kHz, low noise mode)

RF1/RF2/RF4IN	
10 MHz to 2200 MHz	<–100 dBc
2200 MHz to 2700 MHz	<–95 dBc

Inherent spurious response	<–50 dB

Low distortion mode, 20 MHz to 2200 MHz, except 1816.115 MHz

Inherent harmonics

(f_0 = 50 MHz to 2200 MHz, up to 7 GHz)	
RF1, RF2	<–30 dB
RF4IN	<–20 dB

Modulation	GMSK, BxT = 0.3 8PSK[7]
Frequency range	
GSM 400 band	450 MHz to 458 MHz / 478 MHz to 486 MHz
GSM 850 band	824 MHz to 849 MHz
GSM900 band	876 MHz to 915 MHz
GSM1800 band	1710 MHz to 1785 MHz
GSM1900 band	1850 MHz to 1910 MHz

Attenuation of inband spurious emissions	>50 dB
Inherent phase error (GMSK)	<1°, rms <4°, peak
Inherent EVM (8PSK)[7]	<2%, rms
Frequency settling time	<500 µs to res. phase of 4°

Output level range (GMSK)

RF1	–130 dBm to –27 dBm
RF2	–130 dBm to –10 dBm
RF3OUT	–90 dBm to +13 dBm

Output level range (8PSK)[7]

RF1	–130 dBm to –31 dBm
RF2	–130 dBm to –14 dBm
RF3OUT	–90 dBm to +9 dBm

Output level resolution	0.1 dB

Level uncertainty

RF1, RF2	P >–117 dBm
in temperature range	
+23 °C to +35 °C	<0.5 dB
+5 °C to +45 °C	<0.7 dB
RF3OUT	P >–90 dBm to +10 dBm (GMSK) P >–90 dBm to +6 dBm (8PSK)[7]
in temperature range	
+23 °C to +35 °C	<0.7 dB
+5 °C to +45 °C	<0.9 dB

Frequency range

GSM 400 band	460 MHz to 468 MHz / 488 MHz to 496 MHz
GSM 850 band	869 MHz to 894 MHz
GSM900 band	921 MHz to 960 MHz
GSM1800 band	1805 MHz to 1880 MHz
GSM1900 band	1930 MHz to 1990 MHz

[7] with option CMU-K41

Measurement bandwidth	
in measurement menus	500 kHz

Power meter

Level range	
RF1	
continuous power[8]	–40 dBm to +47 dBm (50 W)
Peak Envelope Power[9] (PEP)	+53 dBm (200 W)
RF2	
continuous power	–54 dBm to +33 dBm (2 W)
Peak Envelope Power[9] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	–80 dBm to 0 dBm
Level uncertainty	
RF1, RF2, RF4IN	
in temperature range	
+23 °C to +35 °C	<0.5 dB
+5 °C to +45 °C	<0.7 dB
Level resolution	0.1 dB (0.01 dB via remote control)

Modulation Analysis

Level range (PEP)	
RF1	–6 dBm to +53 dBm
RF2	–20 dBm to +39 dBm
RF4IN	–60 dBm to 0 dBm
Inherent phase error (GMSK)	<0.6°, rms <2°, peak
Inherent EVM (8PSK)[7]	<1,0%, rms
Frequency measurement uncertainty	≤10 Hz + drift of time base

Burst power measurement

Reference level for full dynamic range (GMSK, low noise mode)	
RF1	+10 dBm to +53 dBm
RF2	–4 dBm to +39 dBm
RF4IN	–22 dBm to 0 dBm
Dynamic range (GMSK)	>72 dB (BW= 500 kHz, rms)
Reference level for full dynamic range (8PSK, low noise mode)[7]	
RF1	+6 dBm to +49 dBm
RF2	–8 dBm to +35 dBm
RF4IN	–26 dBm to –4 dBm
Dynamic range	>69 dB (BW= 500 kHz, rms)
Relative measurement uncertainty	
Result >–40 dB	<0.1 dB
–60 dB ≤ result ≤–40 dB	<0.5 dB
Resolution	0.1 dB in active part of burst

Spectrum due to modulation [10]

Level range for full dynamic range	
RF1	+10 dBm to +47 dBm
RF2	–4 dBm to +33 dBm
RF4IN	–22 dBm to 0 dBm
Test method	relative measurement, averaging
Filter bandwidth	30 kHz resolution filter (5 pole)
Measurement at an offset of	100, 200, 250, 400, 600, 800, 1000, 1200, 1400, 1600, 1800 kHz
Dynamic range (noise correction mode) with offset ≥ 1200 kHz	>80 dB

Spectrum due to switching [10]

Level range for full dynamic range	
RF1	+10 dBm to +47 dBm
RF2	–4 dBm to +33 dBm
RF4IN	–22 dBm to 0 dBm
Test method	absolute measurement, max hold over several measurements
Filter bandwidth	30 kHz resolution filter (5 pole)
Measurement at an offset of	100, 200, 250, 400, 600, 800, 1000, 1200, 1400, 1600, 1800 kHz
Dynamic range (noise correction mode) with offset ≥ 1200 kHz	>80 dB

Rated temperature range	+5 °C to +45 °C
Storage temperature range	–25 °C to +60 °C
Humidity	+40 °C, 80% rh, non-condensing; complies with IEC 68-2-3
Display	21 cm TFT color display (8.4")
Resolution	640 x 480 pixels (VGA resolution)
Pixel failure rate	$<2 \times 10^{-5}$
Electromagnetic compatibility	meets requirements of EMC Directive 89/336/EEC (EN50081-1 and EN50082-2)
Mechanical resistance (non operating mode)	
Vibration, sinusoidal	meets IEC68-2-6, IEC1010-1, EN61010-1, MIL-T-28800 D class 5, 5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g const.
Vibration, random	meets DIN IEC 68-2-36, DIN 40046 T24 10 Hz to 300 Hz, acceleration 1.2 g rms
Shock	meets DIN IEC 68-2-27, MIL-STD-810D 40 g shock spectrum
Electrical safety	IEC1010-1, DIN EN61010-1, UL3111-1, CSA22.2 No. 1010-1
Power supply	100 V to 240 V ± 10% (AC), 3.1 A to 1.3 A, 50 Hz to 400 Hz –5% to +10% power factor correction, EN61000-3-2
Power consumption	
Base unit	130 W
With typical options	180 W
Dimensions (W x H x D)	465 mm x 193 mm x 517 mm (19"; 4 height units)
Weight	
Base unit	14 kg
With typical options	18 kg

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[8] 50 W from +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.

[9] Mean value of power vs time must be equal or less than allowed continuous power.

[10] The specifications apply to all cases, in which interfering carriers (up to the same level as the measured carrier) are more than 50 GSM channels away.

ROHDE&SCHWARZ

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Safety Instructions

This unit has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:

Observe operating nstructions	Weight indication for units >18 kg	PE terminal	Ground terminal	Danger! Shock hazard	Warning! Hot surfaces	Ground	Attention! Electrostatic sensitive devices require special care

1. The unit may be used only in the operating conditions and positions specified by the manufacturer. Unless otherwise agreed, the following applies to R&S products:

   IP degree of protection 2X, Pollution severity 2, overvoltage category 2, altitude max. 2000 m.

   The unit may be operated only from supply networks fused with max. 16 A.

2. For measurements in circuits with voltages $V_{rms} > 30$ V, suitable measures should be taken to avoid any hazards.

   (using, for example, appropriate measuring equipment, fusing, current limiting, electrical separation, insulation).

3. If the unit is to be permanently wired, the PE terminal of the unit must first be connected to the PE conductor on site before any other connections are made. Installation and cabling of the unit to be performed only by qualified technical personnel.

4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.

5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.

   If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.

6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.

7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.

   Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.

8. If the unit has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.

   If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.

9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

   Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.

   Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.

   Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.

   (visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

continued overleaf

Safety Instructions

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.
11. Lithium batteries must not be exposed to high temperatures or fire.

    Keep batteries away from children.

    If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).

    Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

    Do not short-circuit the battery.
12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.
13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.
14. Any additional safety instructions given in this manual are also to be observed.

Certified Quality System

ISO 9001

DQS REG. NO 1954-04

Qualitätszertifikat

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist nach ISO 9001 zertifiziert.

Certificate of quality

Dear Customer,

You have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards.
The Rohde & Schwarz quality management system is certified according to ISO 9001.

Certificat de qualité

Cher client,

Vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité.
Le système de gestion qualité de Rohde & Schwarz a été homologué conformément à la norme ISO 9001.

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EC Certificate of Conformity

Certificate No.: 99035

This is to certify that:

Equipment type	Order No.	Designation
CMU200	1100.0008.02	Universal Radio Communication Tester
CMU-B11	1100.5000.02	Option: Reference Oscillator OXCO
CMU-B12	1100.5100.02	Option: Reference Oscillator OXCO
CMU-B15	1100.6006.02	Option: Additional RF und IF Connections
CMU-B21	1100.5200.02	Option: Versatile Signalling Unit
CMU-B41	1100.5300.02	Option: Audio Generator and Analyzer
CMU-B52	1100.5400.02	Option: Spreech Codec for Versatile Signalling Unit
CMU-B53	1100.5700.02	Option: Bluetooth Extension
CMU-B71	1100.6406.02	Option: ABIS Interface Unit
CMU-B81	1100.6506.02	Option: CDMA(IS95) Signalling Unit
CMU-U61	1100.5500.02	Modification: Floppy Disk Drive
CMU-Z1	1100.7490.02	Accessory: Memory Card

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1993 + A2 : 1995
EN50081-1 : 1992
EN50082-2 : 1995

Affixing the EC conformity mark as from 1999

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Support Center

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Für technische Fragen zu diesem Rohde & Schwarz-Gerät steht Ihnen ab sofort unsere Hotline der Rohde & Schwarz Vertriebs-GmbH, Support Center, zur Verfügung.

Unser Team bespricht mit Ihnen Ihre Fragen und sucht Lösungen für Ihre Probleme.

Die Hotline ist Montag bis Freitag von 8.00 bis 17.00 Uhr besetzt.

Bei Anfragen außerhalb der Geschäftszeiten hinterlassen Sie bitte eine Nachricht oder senden Sie eine Notiz per Fax oder e-mail. Wir setzen uns dann baldmöglichst mit Ihnen in Verbindung.

Should you have any technical questions concerning this Rohde & Schwarz product, please contact the hotline of Rohde & Schwarz Vertriebs-GmbH, Support Center.

Our hotline team will answer your questions and find solutions to your problems.

You can reach the hotline Monday through Friday from 8:00 until 17:00.

If you need assistance outside office hours, please leave a message or send us a fax or e-mail. We will contact you as soon as possible.

ROHDE&SCHWARZ

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Contents of Manuals for Universal Radio Communication Tester CMU

Operating Manual CMU200/CMU300

The present operating manual contains comprehensive information about the technical data of the instrument, its setup and putting into operation, the operating concept and controls as well as the operation of the CMU via the menus of the graphical user interface and via remote control. Typical measurement tasks for the CMU are explained in detail using the functions on the graphical user interface and a selection of program examples.

The manual is subdivided into the data sheet plus 10 chapters:

The data sheet	Informs about guaranteed specifications and characteristics of the instrument.
Chapter 1	Describes the control elements and connectors on the front and rear panel as well as all procedures required for putting the instrument into operation and integrating it into a test setup.
Chapter 2	Gives an introduction to typical measurement tasks of the CMU which are explained step by step.
Chapter 3	Describes key operating modes, the structure of the graphical interface and the principles of measurement control.
Chapter 4	Forms a reference for manual control of the CMU and contains a detailed description of all instrument functions belonging to function groups *Base* and *RF Non Signalling.* All software options that come without a separate operating manual are also described at the end of chapter 4. The chapter lists the remote control command for each instrument function.
Chapter 5	Describes the basics for programming the CMU, command processing and the status reporting system.
Chapter 6	Lists all the remote-control commands of the function groups and options reported in chapter 4. At the end of the chapter the commands are listed by their function and in alphabetical order.
Chapter 7	Contains program examples for a number of typical CMU applications.
Chapter 8	Describes preventive maintenance and the characteristics of the instrument's hardware interfaces.
Chapter 9	Gives a list of error messages that the CMU may generate.
Chapter 10	Contains an index for the operating manual.

Service Manual Instrument

The service manual instrument informs on how to check compliance with rated specifications, on instrument function, repair, troubleshooting and fault elimination. It contains all information required for the maintenance of CMU by exchanging modules.

Service Manual Modules

The service manual modules is not delivered with the instrument but may be obtained from your R&S service department using the order number 1100.4903.91.

Service manual modules contains information about the individual modules of CMU. This comprises the test and adjustment of the modules, fault detection within the modules and the interface description.

Operating Manuals for Digital and Analog Network Tests

The operating manuals listed in the following table describe the test of mobile phones supporting different standards by means of the CMU200/CMU300 and the appropriate software and hardware options. Except for hardware-specific chapters that are not relevant to the software options, the network test operating manuals are organized like the present CMU operating manual.

		For Options		
Manual	**Order Number**	**Type**	**Description**	**Stock No.**
Operating Manual CMU-K21/-K22/-K23	1115.6088.12	CMU-K21 CMU-K22 CMU-K23	GSM900-MS for CMU-B21 GSM1800-MS for CMU-B21 GSM1900-MS for CMU-B21	1115.6007.02 1115.6107.02 1115.6207.02
Operating Manual CMU-K27/-K28	1115.6688.12	CMU-K27 CMU-K28	TDMA800-MS for CMU-B21 TDMA1900-MS for CMU-B21	1115.6607.02 1115.6707.02
Operating Manual CMU-K29	1115.6888.12	CMU-K29	AMPS-MS for CMU-B21	1115.6807.02
Operating Manual CMU-K30/-K31/-K32/-K33	1115.4185.12	CMU-K30 CMU-K31 CMU-K32 CMU-K33 CMU-K39 CMU-K41	GSM400-BS for CMU-B21 GSM900-BS for CMU-B21 GSM1800-BS for CMU-B21 GSM1900-BS for CMU-B21 MOC/MTC EDGE for CMU-K30/31/32/33	1115.4004.02 1115.4104.02 1115.4104.02 1115.4104.02 1115.4791.02 1115.4604.02
Operating Manual CMU-K81/-K82	1115.5581.12	CMU-K81 CMU-K82	CDMA800-MS (IS95) for CMU-B81 CDMA1900-MS (IS95) for CMU-B81	1115.5500.02 1115.5600.02
Operating Manual CMU-K53	1115.5081.12	CMU-K53	Bluetooth for CMU	1115.5000.02

The GSM base station tests described in operating manual CMU-K30/-K31/-K32 require a CMU300 (Universal Radio Communication Tester for BTS). All other radio communication equipment is tested with model CMU200.

What's New in this Revision...

The current revision 07 of the CMU operating manual describes firmware V3.0. Compared to previous versions, this new firmware provides numerous extensions and improvements. The new features described in this manual are listed below.

New Features	**Decription**	**Refer to...**
VersionManager	New software tool designed to designed to activate, delete, install, combine, or list different software versions in a convenient way.	Chapter 1, CMU VersionManager
Menu Select	Selection menu for function groups and measurements with a new, easier to handle design.	Chapter 4, Menu Select
RF Measurements, general	Improved and more intuitive operating concept for *Power vs Time* and *Spectrum* measurements in function group RF.	Chapter 4, RF Measurements
RF Spectrum	The *Level Scale* can be set with an extra hotkey.	Chapter 4, Spectrum Measurements
Audio Measurements	Extended functionality in function group *Audio Analyzer and Generator* (option CMU-B41): • Configuration of audio input path. • Multitone application with 20 different tones that can be generated and measured at the same time.	Chapter 4, Multitone Measurements
List of options	Common command *OPT with improved, unambiguous output string.	Chapter 6
Nonvolatile RAM	Remote control command `SYSTem:NONVolatile:DISable` prevents the CMU from storing settings in the nonvolatile RAM.	Chapter 6
Audio Measurements	Remote control command `CONFigure:AFANalyzer[:PRIMary]:MTReduce` to reduce the measurement time of the AF analyzer.	Chapter 6

Frequently Used Abbreviations

Att.	*Attenuation*
Cnt	*Center*
Ext.	*External*
Freq.	*Frequency*
GPIB	*General Purpose Interface Bus = IEEE Bus*
IF	*Intermediate Frequency*
Max.	*Maximum (Level)*
Pk	*Peak*
RBW	*Resolution Bandwidth*
Ref.	*Reference*
Rel.	*Relative*
RF	*Radio Frequency*
SSB	*Single Side Band*
SW	*Software*

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- Connecting a Printer 1.16
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Software Update and Version Management **1.17**
- CMU VersionManager 1.17

1 Preparation for Use

This chapter describes the controls and connectors of the Universal Radio Communication Tester CMU and gives all information that is necessary to put the instrument into operation and connect external devices. Notes on reinstallation of the CMU software and a description of the *VersionManager* terminate this chapter.

Caution!

Please make sure to observe the instructions of the following sections in order not to cause damage to the instrument or endanger people. This is of particular importance when the instrument is used for the first time. Also observe the general safety instructions at the beginning of this manual.

A more detailed description of the hardware connectors and interfaces can be found in chapter 8. Chapter 2 provides an introduction to the operation of the CMU by means of typical examples of configuration and measurement; for a description of the operating concept refer to chapter 3.

For remote control of the CMU refer to the general description of the SCPI commands, the instrument model, the status reporting system and measurement control in chapter 5.

Front and Rear View

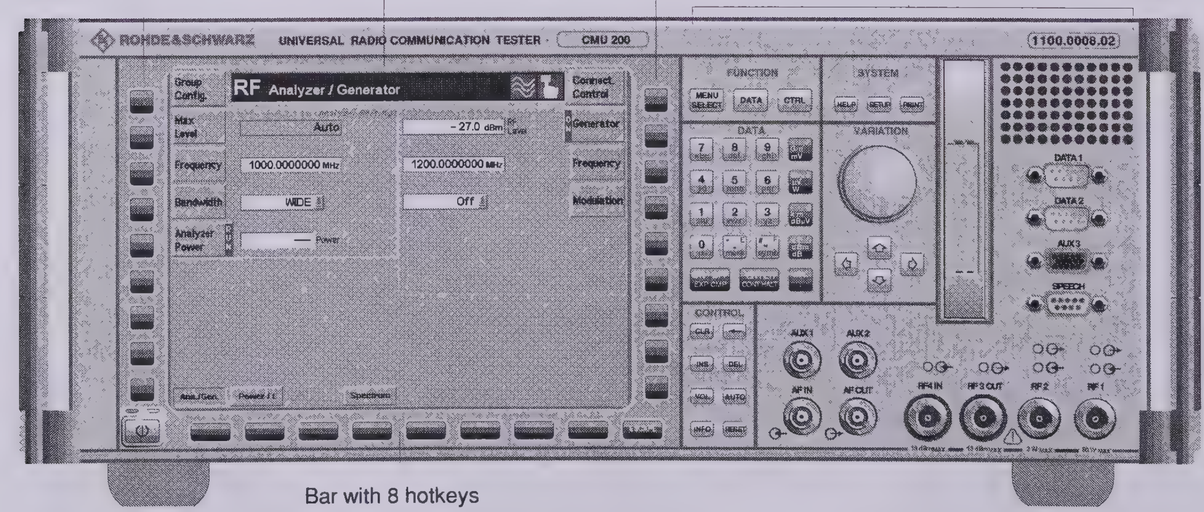
The front panel of the CMU consists of the VGA display with the softkey area (left side) and the hardkey area (right side, see Fig. 1-1). Brief explanations on the controls and connectors of the hardkey area and the rear panel are to be found on the next pages. Operation by means of softkeys is described in chapter 3, *Manual Operation.*

9 softkeys with alternating function, ON/Standby key (p. 4)

LC display with menu example

9 softkeys with alternating function, Escape key (p. 4)

Keys and connectors


ROHDE&SCHWARZ
UNIVERSAL RADIO COMMUNICATION TESTER
CMU 200
1100.0008.02
RF Analyzer / Generator
Group Config.
Max Level
Auto
-27.0 dBm
Frequency
1000.0000000 MHz
1200.0000000 MHz
Bandwidth
WIDE
Off
Analyzer Power
Connect Control
Generator
Modulation
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
VARIATION
CONTROL
DATA 1
DATA 2
AUX 3
SPEECH
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF3 OUT
RF 2
RF 1

Bar with 8 hotkeys

Fig. 1-1 CMU front view

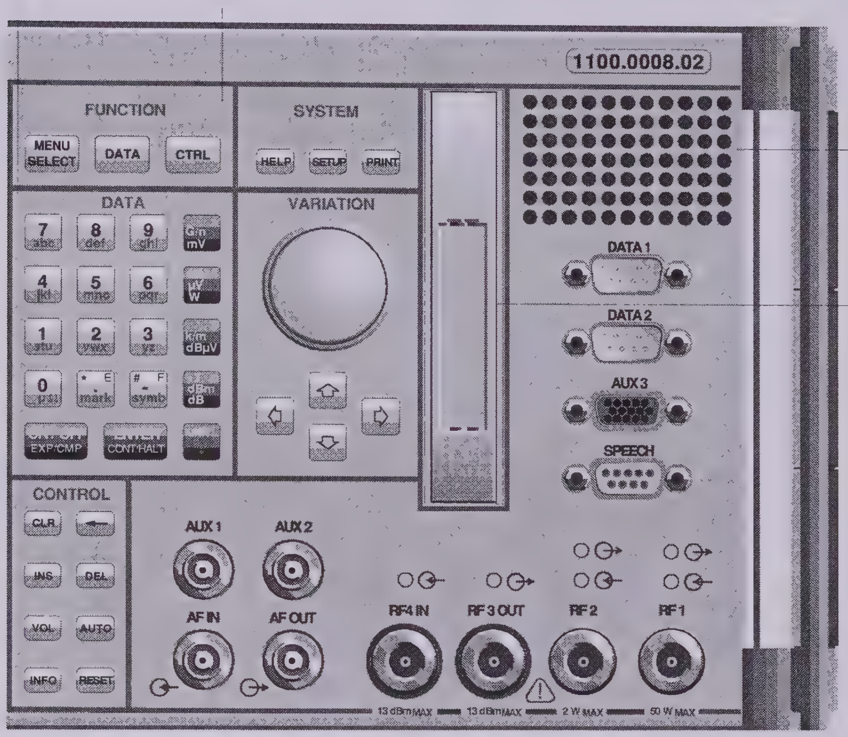
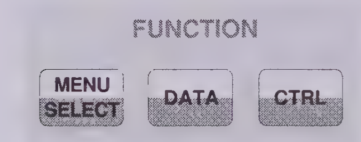

Data input
Selection of the most important CMU functions via menus
Loudspeaker, for future extensions
PCMCIA interface
as an alternative: Floppy disk drive (option CMU-U61)
1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
VARIATION
CONTROL
CLR
INS
DEL
VOL
AUTO
INFO
RESET
DATA 1
DATA 2
AUX 3
SPEECH
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1
13 dBm MAX
13 dBm MAX
2 W MAX
50 W MAX

Fig. 1-2 CMU front view – hardkeys

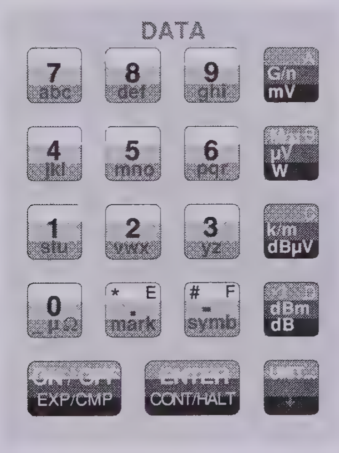
FUNCTION


FUNCTION
MENU SELECT
DATA
CTRL

Preselection of the menus:

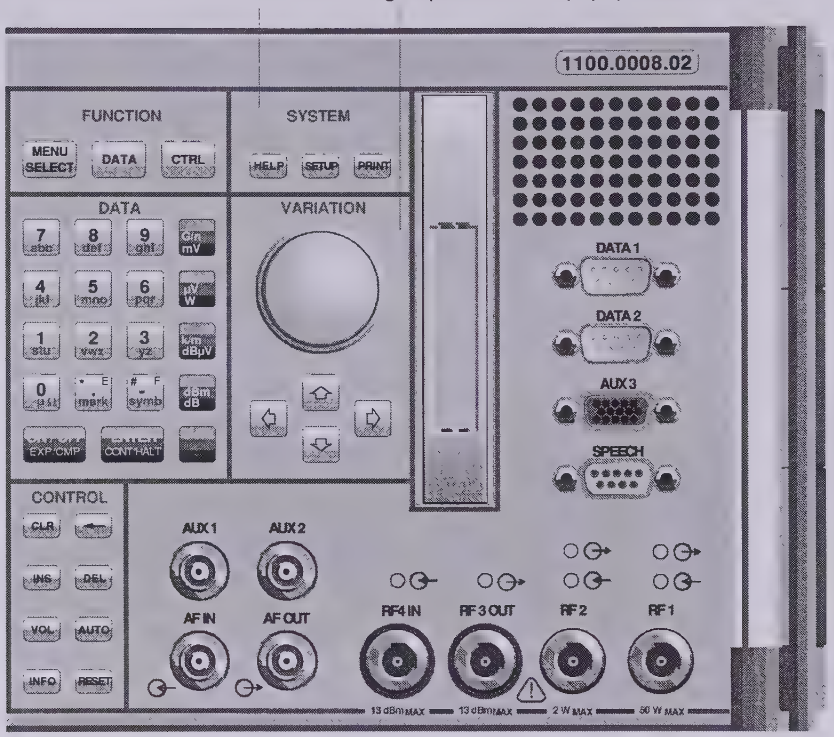
MENU SELECT	Menu selection	☞ Chap. 3
DATA	For future extensions	
CTRL	For future extensions	

DATA


DATA
7 abc
8 def
9 ghi
G/n mV
4 jkl
5 mno
6 pqr
µV W
1 stu
2 vwx
3 yz
k/m dBµV
0 µΩ
* . E mark
# - F symb
dBm dB
EXP/CMP
CONT/HALT

Data input:

0 ... 9	Numerical input (letters for string editors)	☞ Chap. 3
**. E*	Special characters, dec. point, hex value "E"	
# - F	Spec. characters, sign change, hex value "F"	
G/n mV A	Factor $10^9/10^{-9}$, unit, hex value "A"	
M/µ µV W	Factor $10^6/10^{-6}$, unit, hex value "B"	
k/m dB µV	Factor $10^3/10^{-3}$, unit, hex value "C"	
**1 dBm dB*	Factor 10^0, unit, hex value "D"	
ON / OFF *EXP/COMP*	Switching on/off editors/measurements	
ENTER *CONT/HALT*	Confirmation of entry in editors Calling/quitting editors, measurement control	
UNIT ⇩	For future extensions	

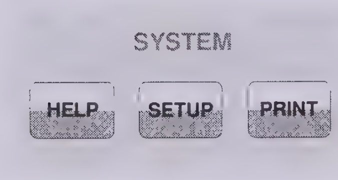

System control

Variation of numeric values and group selection in popup menus

1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
7 abc
8 def
9 ghi
G/n mV
4 jkl
5 mno
6 pqr
μ/V W
1 stu
2 vwx
3 yz
k/m dBμV
0
mark
symb
dBm dB
EXP CMP
CONT HALT
VARIATION
CONTROL
CLR
INS
DEL
VOL
AUTO
INFO
RESET
DATA 1
DATA 2
AUX 3
SPEECH
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1
13 dBm MAX
13 dBm MAX
2 W MAX
50 W MAX

Fig. 1-3 CMU front view – hardkeys

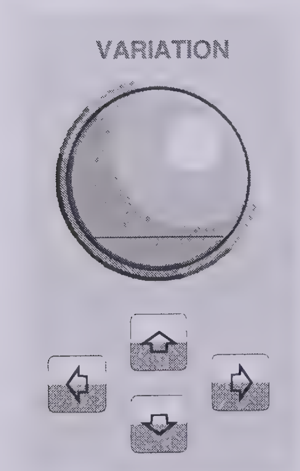
SYSTEM


SYSTEM
HELP
SETUP
PRINT

System control:

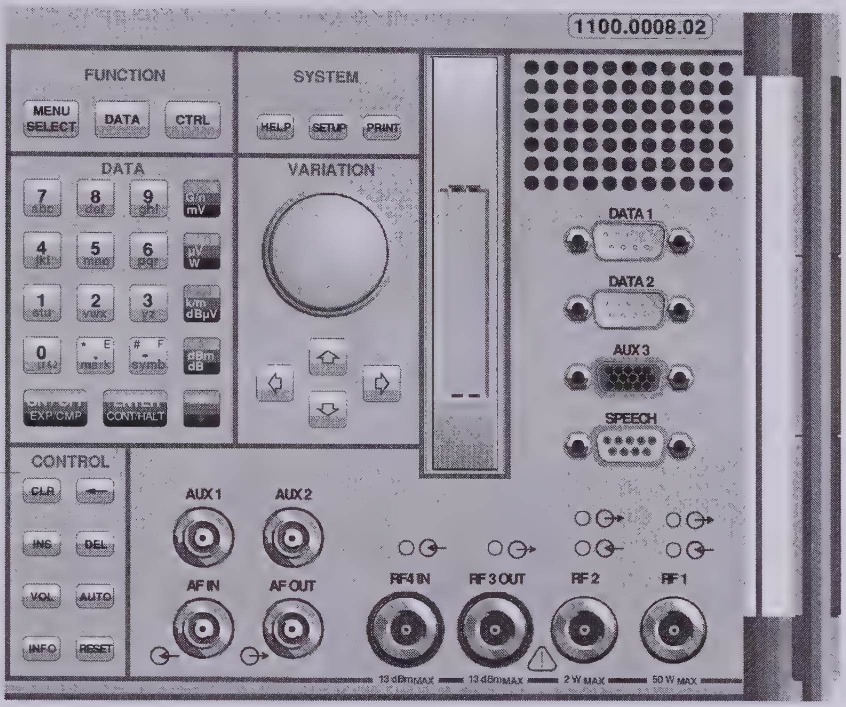
HELP	For future extensions	☞	Chap. 3
SETUP	Instrument settings		
PRINT	Initialize printing of a screenshot		

VARIATION



Value variation and group selection:

Rotary knob	Value variation in input fields and parameters, line selection in tables, field selection in popup menus. Press to expand/compress tables and pull-down lists and to confirm entries and selections.	☞	Chap. 3
Cursor key vertical	Group selection in popup menus (vertical)		
Cursor key horizontal	Group selection in popup menus (horizontal), Cursor positioning in editors and tables		


1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
7 abc
8 def
9 ghi
mV
4 jkl
5 mno
6 pqr
W
1 stu
2 vwx
3 yz
k/m dBµV
0
mark
symb
dBm dB
EXP/CMP
CONT/HALT
VARIATION
DATA 1
DATA 2
AUX 3
SPEECH
CONTROL
CLR
INS
DEL
VOL
AUTO
INFO
RESET
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1
13 dBm MAX
13 dBm MAX
2 W MAX
50 W MAX

Extended editor and instrument control functions

Fig. 1-4 CMU front view – hardkeys

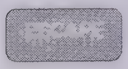
CONTROL

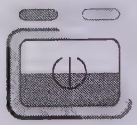
CONTROL
CLR
INS
DEL
VOL
AUTO
INFO
RESET

Extended control functions:

CLR	Clears the complete editor string	☞ Chap. 3
⇦	Deletes the character to the left of the cursor (back space)	
INS	Changes between insertion and overwriting in the editor	
DEL	Deletes the character marked by the cursor	
VOL	For future extensions	
AUTO	For future extensions	
INFO	System info and hardware diagnosis	
RESET	Resets to default values	

Further Keys





ESCAPE	Quits popup menus, closes an editor discarding the entries made	☞ Chap. 3
ON/STANDBY	Switches between operation (green LED) and standby (orange LED)	

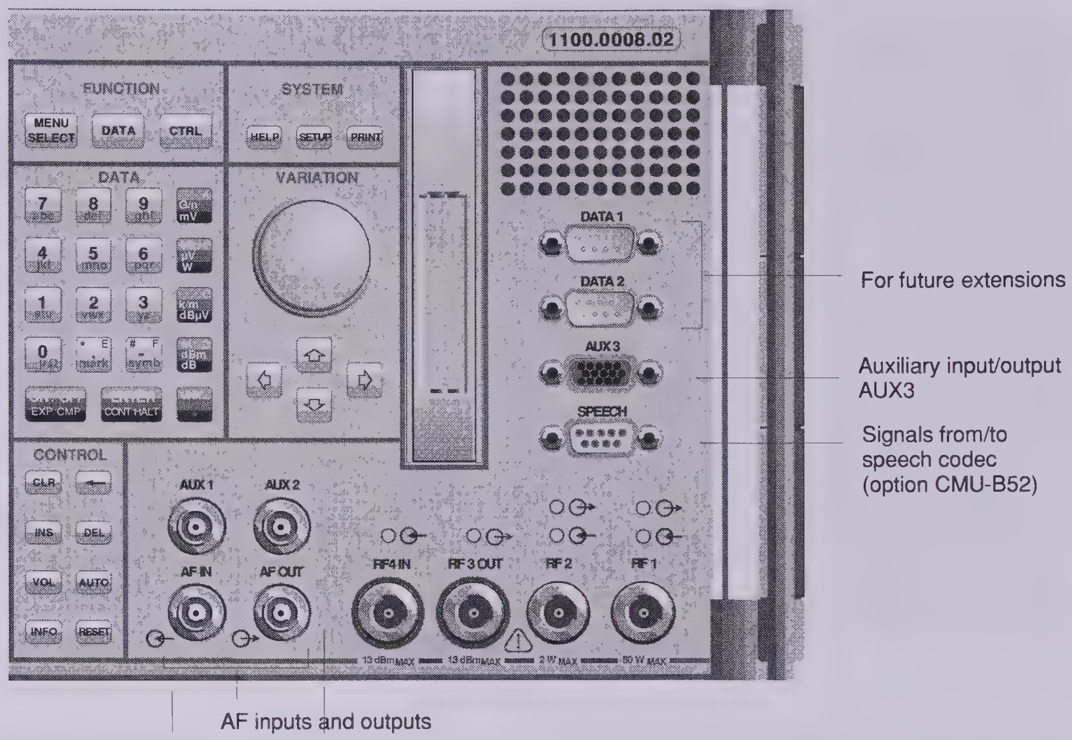
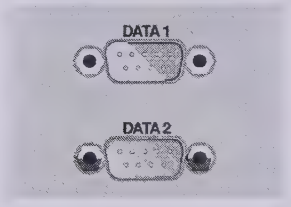

1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
VARIATION
CONTROL
CLR
INS
DEL
VOL
AUTO
INFO
RESET
DATA 1
DATA 2
AUX 3
SPEECH
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF 3 OUT
RF 2
RF 1
13 dBm MAX
13 dBm MAX
2 W MAX
50 W MAX
For future extensions
Auxiliary input/output AUX3
Signals from/to speech codec (option CMU-B52)
AF inputs and outputs

Fig. 1-5 CMU front view connectors

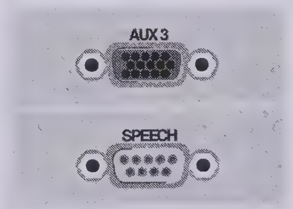
DATA1, DATA2


DATA 1
DATA 2

For future extensions

☞ Chapter 8, "Hardware connectors"

AUX 3 and SPEECH


AUX 3
SPEECH

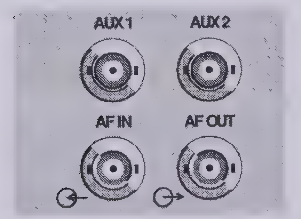
Input/output for timing and external trigger signal
CMU300: External trigger signal for wired synchronization

☞ Chapter 8, "Hardware connectors "

Signals from/to speech codec (option CMU-B52)

☞ Chapter 8, "Hardware connectors"

AF connectors

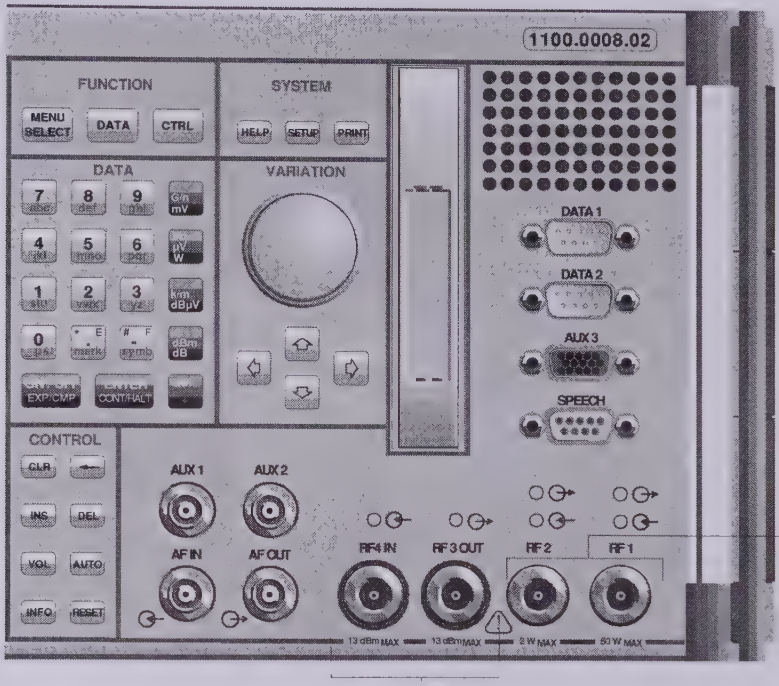

AUX1
AUX2
AF IN
AF OUT

Connectors for audio signals:

AUX1/2	Additional input/output for audio signals that may be used in remote control (secondary audio analyzer)
AF IN/OUT	Standard input/output for the (primary) audio analyzer

☞ Chapter 4, "Audio Generator and Analyzer"; Chapter 8, "Hardware connectors"

Caution: *Note the maximum permissible input levels for all AF connectors according to the data sheet in order to prevent damage to the instrument!*

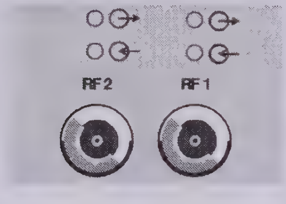

1100.0008.02
FUNCTION
MENU SELECT
DATA
CTRL
SYSTEM
HELP
SETUP
PRINT
DATA
VARIATION
7 abc
8 def
9 ghi
G/n mV
4 jkl
5 mno
6 pqr
μ/V W
1 stu
2 vwx
3 yz
k/m dBμV
0
dBm dB
EXP/CMP
CONT/HALT
CONTROL
CLR
INS
DEL
VOL
AUTO
INFO
RESET
AUX 1
AUX 2
AF IN
AF OUT
RF4 IN
RF3 OUT
RF 2
RF 1
DATA 1
DATA 2
AUX 3
SPEECH
13 dBm MAX
13 dBm MAX
2 W MAX
50 W MAX

Bidirectional RF connectors RF 1 und RF 2

Sensitive RF input, high-level RF output

Fig. 1-6 CMU front view– connectors

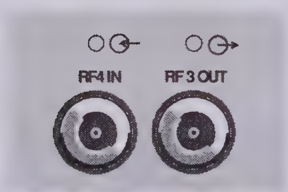
RF connectors



Bidirectional RF connectors for various power ranges according to the data sheet.

The two LEDs above the connectors are illuminated as long as the CMU sends signals ⊖→ or is ready for reception ⊖←.

☞ Chapter 8, "Hardware connectors "


RF4 IN
RF3 OUT

Connector with high output level and connector for sensitive RF measurements (antennas). Power ranges according to the data sheet. Maximum permissible input and output level according to the label on the front panel.

☞ Chapter 8, "Hardware connectors"

The two LEDs above the connectors are illuminated as long as the CMU sends signals ⊖→ or is ready for reception ⊖←.

⚠

Caution:

Note the maximum permissible input levels for all RF connectors according to the label on the front panel or the data sheet in order to prevent damage to the instrument!

RF connectors may warm up very much when high RF power is fed in!

Rear View

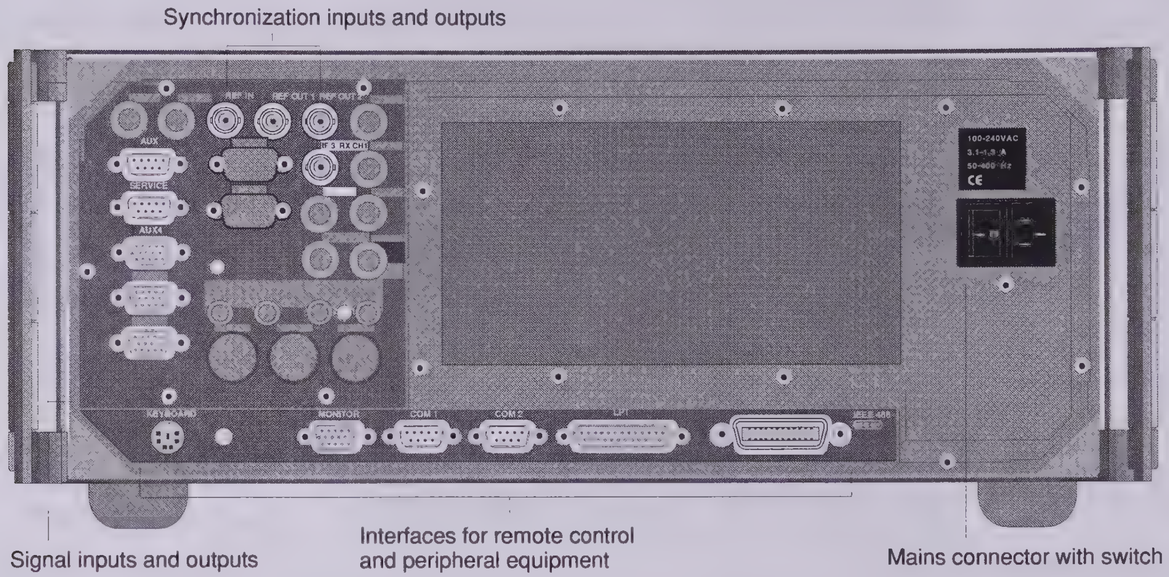
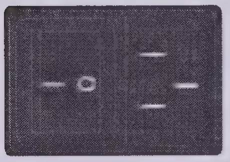
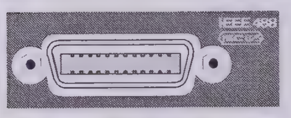
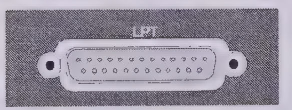
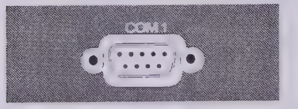
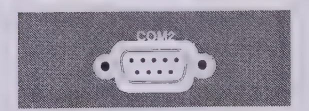
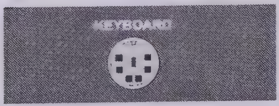

Synchronization inputs and outputs
REF IN
REF OUT 1
REF OUT 2
AUX
SERVICE
AUX4
IF 3 RX CH1
KEYBOARD
MONITOR
COM 1
COM 2
LPT
IEEE 488
100-240VAC
CE
Signal inputs and outputs
Interfaces for remote control and peripheral equipment
Mains connector with switch

Fig. 1-7 CMU rear view

Mains switch

	Mains power switch Mains connector	☞ Chapter 1, "Switching on the Instrument, Startup test" ☞ Chapter 1, "Connecting the instrument to the AC supply"

Interfaces

	GPIB-bus connector (IEEE 488 / IEC 625),	☞ Chapter 8, "Hardware Interfaces "
	Parallel interface: 25-contact printer connector, Centronics-compatible	☞ Chapt. 1, "Connecting an Output Device" Chapter 8, "Hardware Interfaces"
	Connector for serial interface 1: 9-contact Sub-D connector	☞ Chapter 8, "Hardware Interfaces"
	Connector for serial interface 2: 9-contact Sub-D connector	☞ Chapter 8, "Hardware Interfaces"
	Connector for an external VGA monitor: 15-contact Sub-D connector	☞ Chapter 1, "Connecting a Monitor" Chapter 8, "Hardware Interfaces"
	Connector for external keyboard (PS/2), 6-contact Mini DIN connector	☞ Chapter 1, "Connecting an External Keyboard" Chapter. 8, "Hardware Interfaces"

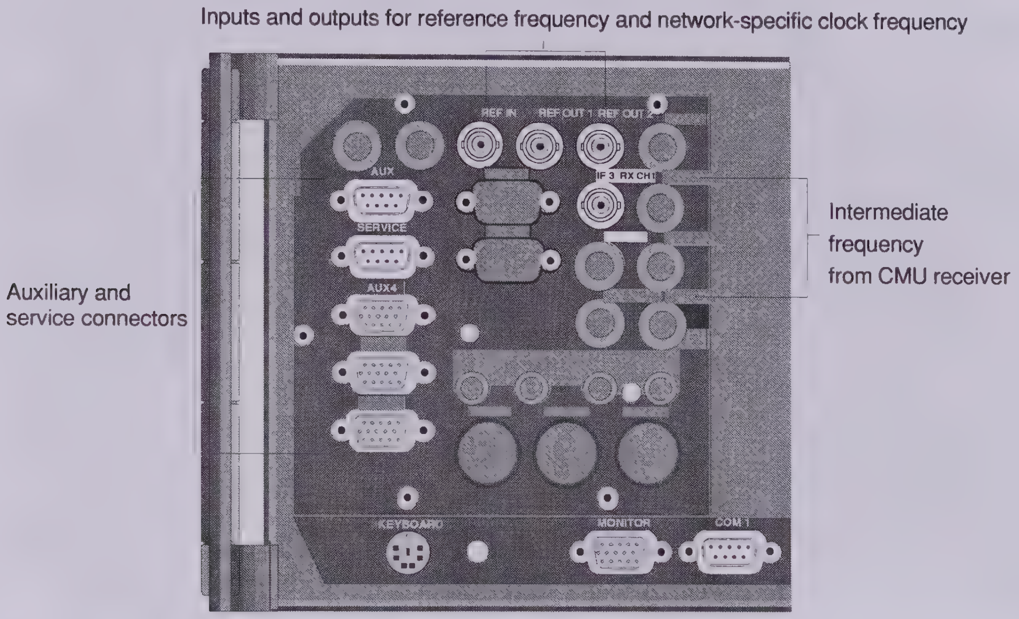
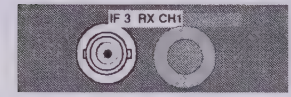

Inputs and outputs for reference frequency and network-specific clock frequency
REF IN
REF OUT 1
REF OUT 2
IF 3 RX CH1
Intermediate frequency from CMU receiver
AUX
SERVICE
AUX4
Auxiliary and service connectors
KEYBOARD
MONITOR
COM 1

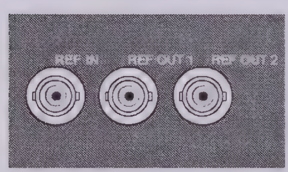
Fig. 1-8 CMU rear view – signal inputs and outputs

Intermediate frequency



IF3 RX CH1 (BNC connector) from CMU receiver ☞ Chapter 8, "Hardware Connectors"

Reference frequency

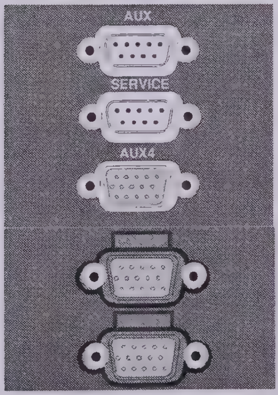

REF IN
REF OUT 1
REF OUT 2

REF IN	Input for external reference frequency	☞ Chapter 8, "Hardware Connectors
REF OUT 1	Output of reference frequency of CMU: 10 MHz or the signal of input REF IN	☞ Chapter 3, "RF Connection Control"
REF OUT 2	Output for network-specific clock frequency	

Caution!

Do not use open or unshielded cables in order to comply with EMC directives!

AUX, SERVICE, AUX4, extensions


AUX
SERVICE
AUX4

Two 9-contact and one 15-contact SUB-D connector: ☞ Chapter 8, "Hardware Connectors

AUX	Auxiliary connector
SERVICE	Service connector for RXTX board (only for internal test purposes)
AUX4	Bidirectional input/output for digital status, control, and trigger signal

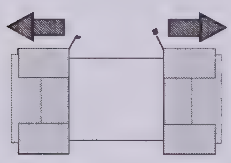
The remaining 15-contact SUB-D connectors are reserved for future extensions. ☞ Chapter 8, "Hardware Connectors

Putting the Instrument into Operation

Caution!

Please make sure to follow the instructions of the following sections in order not to cause damage to the instrument or endanger people. This is of particular importance when using the instrument for the first time.

Unpacking the Instrument



remove protective cabs

- ➢ Take the instrument out of the shipping box and check whether the items listed in the packing list (see separate yellow sheet after the title page of this manual) are all included.
- ➢ Remove the two protective caps from the front and rear of the CMU and carefully check the instrument for damage.

Should the instrument be damaged, immediately notify the forwarder who shipped the instrument to you and keep the box and packing material.

For further transport or shipment of the CMU the original packing should be used, too. It is recommended to keep at least the two protective caps for front and rear side in order to prevent damage to the controls and connectors. The caps are also necessary if the CMU is transported in its transit case that can be ordered from Rohde & Schwarz.

Setting up the Instrument

Permissible operating positions of the CMU

- Horizontal position, standing on the feet.
- For applications in the laboratory or on a work bench, it is recommended that the support feet on the bottom of the instrument be extended. For the LCD display, this provides the optimum viewing angle which typically ranges from perpendicular to the display front to approximately 30° below.

Warning!

The feet must be fully folded in or out. Only in this way can the stability of CMU be guaranteed and reliable operation be ensured. With the feet out, the weight of other units put onto CMU must not exceed 30 kg. The units must be secured against slipping (eg by locking the feet of the unit at the top side of the enclosure).

When shifting the unit with the feet out, the feet might collapse and fold in. To avoid injuries, the unit must therefore not be shifted with the feet out.

Notes: *For safe and convenient operation of the instrument note the following:*

- ➢ Do not cover the rear and lateral ventilation holes.
- ➢ Note the permissible ambient temperature according to the data sheet.
- ➢ Avoid moisture condensation. If it however occurs, the instrument must be wiped dry before switching on.

- Note the warm-up time of the temperature-controlled OCXO reference oscillator (Option CMU-B11/B12), see data sheet.

Mounting in a Rack

Using the adapter ZZA-411 (order number 1096.3283.00) the instrument can be mounted in 19" racks according to the mounting instructions supplied with the rack adapter.

Note: *For convenient operation of the instrument note the following:*

- Allow for sufficient air supply in the rack.
- Make sure that there is sufficient space between the ventilation holes and the rack casing.

Connecting the Instrument to the AC Supply

Caution!

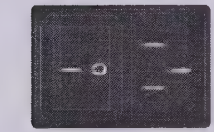
After moisture condensation, allow the instrument to dry before switching on.

Note the permissible ambient temperature according to the data sheet.

Do not cover the lateral and rear ventilation holes.

The CMU may be connected to one-phase AC supplies with nominal voltages ranging from 100 V to 240 V and nominal frequencies ranging from 50 Hz to 400 Hz (see inscription on the rear panel and data sheet). Depending on the options installed, the power consumption ranges from 120 W to 230 W.

Note: *The CMU is automatically adapted to the AC supply voltage applied. External switchover or adaptation of the fuses are not necessary.*



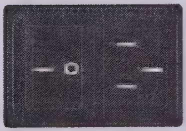
Mains connector

For the mains connection use the supplied mains connector.

As the instrument is designed according to the regulations for safety class EN61010, it must be connected to a power outlet with earthing contact.

Switching on the Instrument / Startup Test

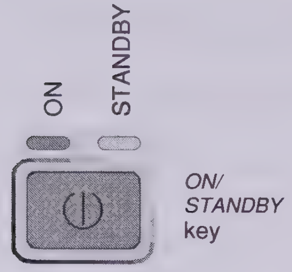
The CMU can be switched on using the mains switch at the rear of the instrument and the *ON/STANDBY* key at the bottom left of the instrument front.



Mains switch

The *mains switch* can be set to two positions:

0	The *0* position implies an all-pole disconnection of the instrument from the mains.
I	In the *I* position, the instrument is in standby mode or in operation, depending on the position of the ON/STANDBY key at the front of the instrument.



The *ON/STANDBY* key activates two different operating modes indicated by colored LEDs:

Standby Only the OCXO reference frequency oscillator (Option CMU-B11/B12), if installed, is supplied with operating voltage. The orange LED (STANDBY) on the right is illuminated.

Operation In this operating mode, all modules of the instrument are supplied with operating voltage. The green LED (ON) on the left is illuminated.

Start procedure

- ➢ To switch on the CMU set the mains switch to the position I.

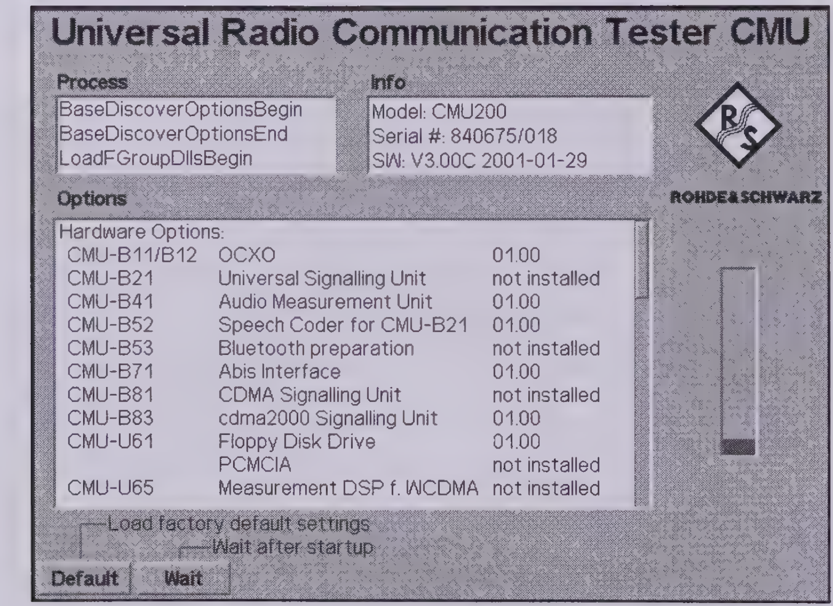
The CMU enters standby mode.

- ➢ Set the CMU to operating mode by pressing the *ON/STANDBY* key once.

Caution! *When switching on the CMU, no disk should be inserted in the drive; otherwise, one of the actions stored on the flash disk will be performed.*

Startup menu

After activation of the operating mode, the startup menu appears for a few seconds. While it is displayed the CMU performs a startup test.



Universal Radio Communication Tester CMU

Process
BaseDiscoverOptionsBegin
BaseDiscoverOptionsEnd
LoadFGroupDllsBegin

Info
Model: CMU200
Serial #: 840675/018
SW: V3.00C 2001-01-29

Options
Hardware Options:

CMU-B11/B12	OCXO	01.00
CMU-B21	Universal Signalling Unit	not installed
CMU-B41	Audio Measurement Unit	01.00
CMU-B52	Speech Coder for CMU-B21	01.00
CMU-B53	Bluetooth preparation	not installed
CMU-B71	Abis Interface	01.00
CMU-B81	CDMA Signalling Unit	not installed
CMU-B83	cdma2000 Signalling Unit	01.00
CMU-U61	Floppy Disk Drive	01.00
	PCMCIA	not installed
CMU-U65	Measurement DSP f. WCDMA	not installed

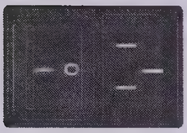
Displays in startup menu

The display windows of the startup menu provide information on

- The startup procedure (*Process)*
- Instrument model, serial number and version of the CMU base software *(Info).*
- Installed hardware and software options and equipment *(Options).* Available software options are listed with their version numbers.
- Progress of the startup procedure (*Startup* bar graph).

After terminating the startup procedure, the instrument changes to the last main menu or graphical measurement menu of the previous session.

Switching off the Instrument



Mains switch

In order not to lose any settings that have been made, proceed in the following order to switch off the CMU:

- ➢ Remove any storage medium from the PCMCIA interface or floppy disk drive.
- ➢ Set the *ON/STANDBY* key to standby mode by pressing once.
- ➢ Set the mains switch at the rear to the 0 position.

How to Ensure EMC

In order to avoid electromagnetic interference, the instrument may only be operated when it is closed and with all shielding covers fitted. Only appropriate shielded signal and control cables may be used.

Input Level

Caution!

– *In order to prevent damage to the instrument note the maximum permissible input levels at the AF inputs AF IN and AUX 1 as well as for the RF inputs RF 1, RF 2 and RF 4 IN at the front of the instrument.*

Connecting the CMU to the Test Setup

Warning:

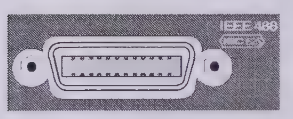
Connect aexternal devices and peripherals only when the instrument is switched off or in STANDBY mode. Otherwise, future errors cannot be excluded.

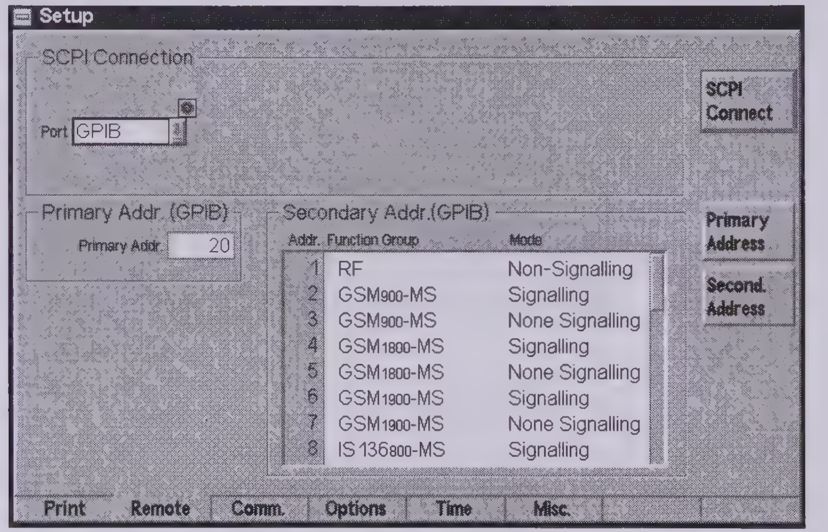
Connecting a Controller

The CMU can be connected to an external controller via the GPIB bus (IEEE bus according to standard IEEE 488; throughout this documentation we will primarily use the term GPIB bus which is also used in the operating menus and in the SCPI command syntax) or via serial interface:

Connection via GPIB bus

The CMU is connected to the GPIB interface of the controller via the GPIB bus connector (IEEE 488 / IEC 625) at the rear of the instrument and a shielded cable. The technical specifications of the GPIB interface are listed in section "Hardware Interfaces " in Chapter 8.





Port: GPIB

Primary Addr. (GPIB): Primary Addr. 20

Secondary Addr.(GPIB)

Addr.	Function Group	Mode
1	RF	Non-Signalling
2	GSM900-MS	Signalling
3	GSM900-MS	None Signalling
4	GSM1800-MS	Signalling
5	GSM1800-MS	None Signalling
6	GSM1900-MS	Signalling
7	GSM1900-MS	None Signalling
8	IS 136800-MS	Signalling

GPIB Bus Configuration

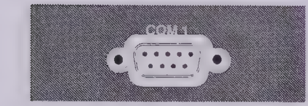
The parameters for GPIB bus control of the CMU are set via the popup menu *Remote* in the menu group *Setup* (in the following abbreviated by *Setup – Remote,* see also chapter 4, p. 4.8, *Settings for Remote Control*).

- ➢ To open the menu *Setup - Remote* press the *SETUP* key at the front of the instrument and activate the *Remote* hotkey at the lower edge of the screen.
- ➢ Select the GPIB bus interface for the transmission by means of the setting *GPIB* in the list field *Port* of the softkey *SCPI Connect.*

The bus address is factory-set to 20. It can be changed in the input field of the softkey *Primary Address.*

Connection via serial interface

The CMU can be connected to the serial interface of a controller via one of the serial interfaces COM 1 or COM 2 and a so-called null-modem cable. The pin assignment and wiring of a null-modem cable are described in section *Handshake* of chapter 8. The technical specifications of the serial (RS-232-C) interface are also discussed in chapter 8 (refer to section *Hardware Interfaces*).



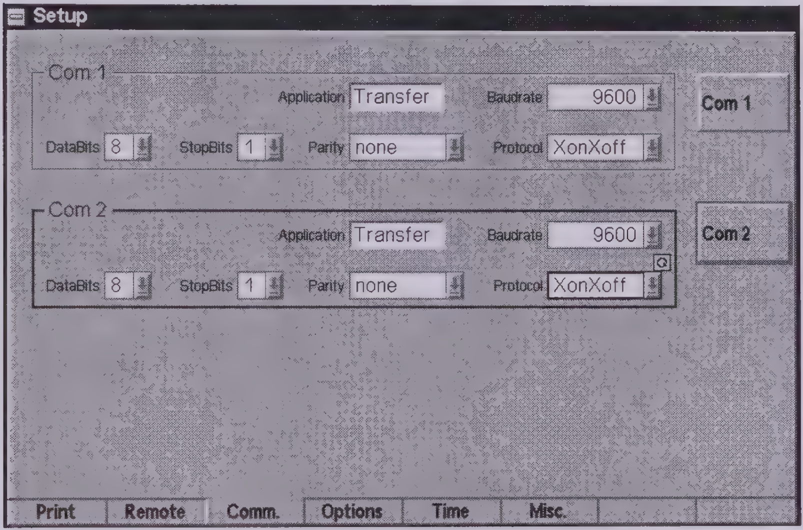
Either a 25-pin or a 9-pin connector can be used on the controller side. It may be necessary to use an appropriate adapter (see chapter 8, *Hardware Interfaces*).

Selection

- ➢ In the *Port* list field of the *SCPI Connect* softkey, select COM 1 or COM 2 to activate one of the RS-232 interfaces for data transfer.

Configuration

After selection of a serial interface, the transmission parameters must be set such as to comply with the parameters of the addressed device. This is done in *the Comm. (communications)* tab of the *Setup* menu:

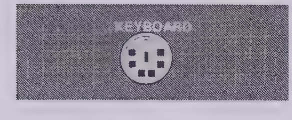


Com 1
Application Transfer
Baudrate 9600
DataBits 8
StopBits 1
Parity none
Protocol XonXoff

Com 2
Application Transfer
Baudrate 9600
DataBits 8
StopBits 1
Parity none
Protocol XonXoff

- ➢ To open the menu *Setup – Comm.* press the *SETUP* key at the front of the instrument and activate the *Comm.* hotkey at the lower edge of the screen.
- ➢ Press the softkey corresponding to the selected COM port and check the settings for the *Baudrate, Data Bits, Parity,* and *Protocol.*

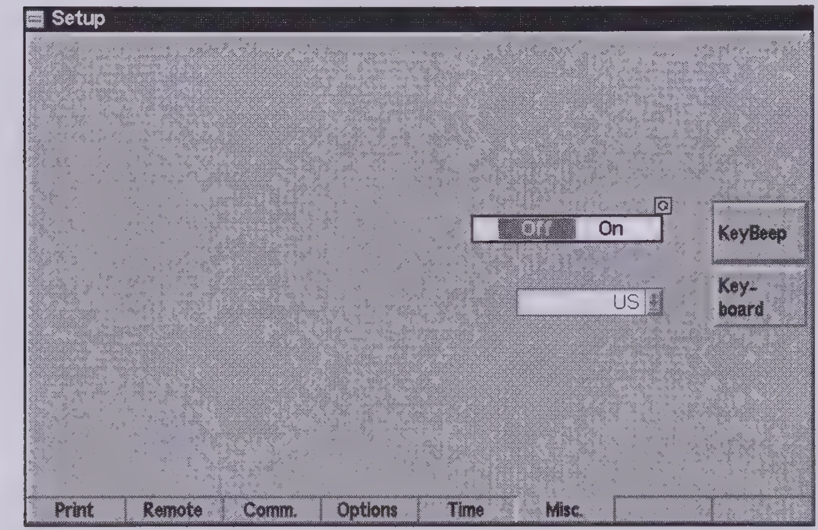
Connecting an External Keyboard



The 6-contact Mini DIN connector at the rear of the instrument permits to connect an external PC keyboard (PS/2) to the CMU. An external keyboard facilitates the input of numbers and texts.

For the interface description see section "Hardware Interfaces" in chapter 8.

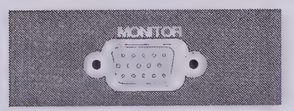
The assignment of the keys can be changed in the *Misc.* tab of the *Setup* menu:



Language assignment

- ➢ To open the menu *Setup – Misc.* press the *SETUP* key at the front of the instrument and activate the *Misc.* hotkey at the lower edge of the screen.
- ➢ Press the *Keyboard* softkey and set the desired key assignment *(US* or *German).*

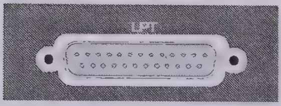
Connecting a Monitor



The 15-contact Sub-D connector at the rear of the instrument permits an external VGA monitor to be connected to the CMU.

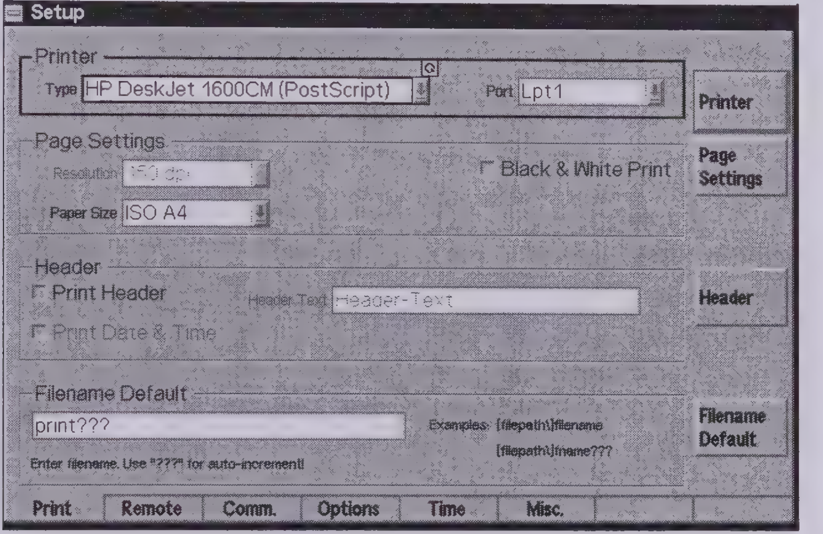
For the interface description see section "Hardware Interfaces" in chapter 8.

Connecting a Printer



A printer can be connected via the 25-contact parallel interface *LPT* at the rear of the instrument (recommended) or one of the serial interfaces COM 1 or COM 2. For the interface description see section "Hardware Interfaces" in chapter 8.

The printer type and port must be set in the *Print* tab of the *Setup* menu:

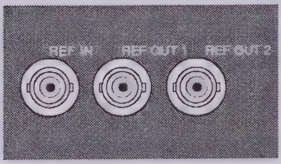

Setup
Printer
Page Settings
Header
Filename Default
Printer
Page Settings
Header
Filename Default
Print
Remote
Comm.
Options
Time
Misc.

Type HP DeskJet 1600CM (PostScript)
Port Lpt1
Resolution 150 dpi
☐ Black & White Print
Paper Size ISO A4
☐ Print Header
Header Text Header-Text
☐ Print Date & Time
print???
Examples: [filepath\]filename
[filepath\]fname???
Enter filename. Use "???" for auto-increment!

- ➢ To open the menu *Setup – Print* press the *SETUP* key at the front of the instrument and activate the *Print* hotkey at the lower edge of the screen.
- ➢ Press the *Printer* softkey and set the printer type and port *(COM 1* or *COM 2* for the serial (RS-232) ports; *LPT 1* for the parallel printer port).

It is recommended to connect the output device to the parallel interface *LPT*, if possible: With this selection, configuration of the interface is not necessary; besides, the serial connectors may be used for GPIB bus etc.

Synchronization with External Devices; Connection of Further Components


REF IN
REF OUT 1
REF OUT 2

For synchronization of the CMU with external devices, the three BNC female connectors REF IN, REF OUT 1, REF OUT 2 are provided.

Software Update and Version Management

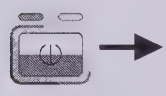
Your CMU was delivered with the latest software and firmware version available. New firmware can be easily installed via the floppy disk drive (option CMU-U61) or the PCMCIA interface on the front of the instrument. In this case, the additional software options must be enabled by means of a key code entered in the *Setup – Options* menu (see chapter 4, p. 4.10).

Installation of new firmware versions and the use of different applications and versions on the same instrument is made easier by the *VersionManager* described in the following section. Installation instructions are also given in chapter 1 of the operating manuals for the individual software options.

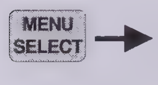
CMU VersionManager

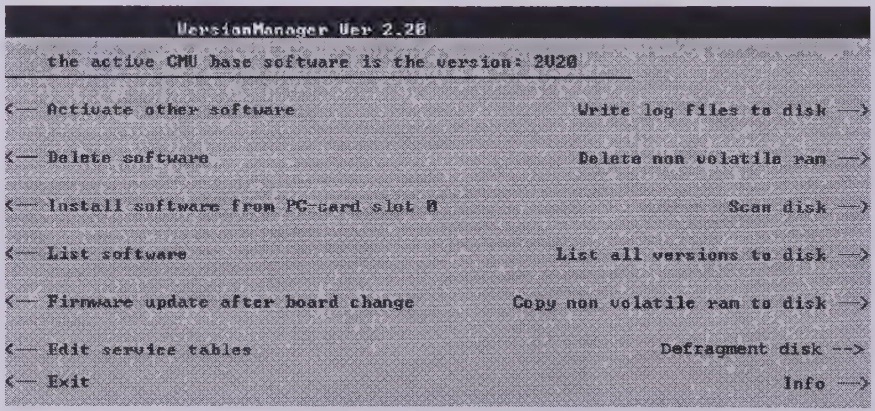
The *VersionManager* is a tool designed to activate, delete, install, combine, or list different software versions in a convenient way. Moreover, it provides information on the hardware and software configuration of the instrument *(Edit service tables, Scan disk)*, resets the startup settings stored in the *non volatile ram* and copies information to an external storage medium *(Write log files to disk, List all versions to disk)*.

The *VersionManager* is part of each CMU firmware version. It is opened automatically after the boot-up process if the CMU detects a storage medium in its floppy disk drive/PCMCIA slot that contains an installation version of the CMU firmware. Alternatively, it can be called up by pressing the *Menu Select* key after the boot-up sequence is terminated (from the moment when the CMU display turns black until the end of the 3-beep acoustic signal).



with floppy / PCMCIA card or



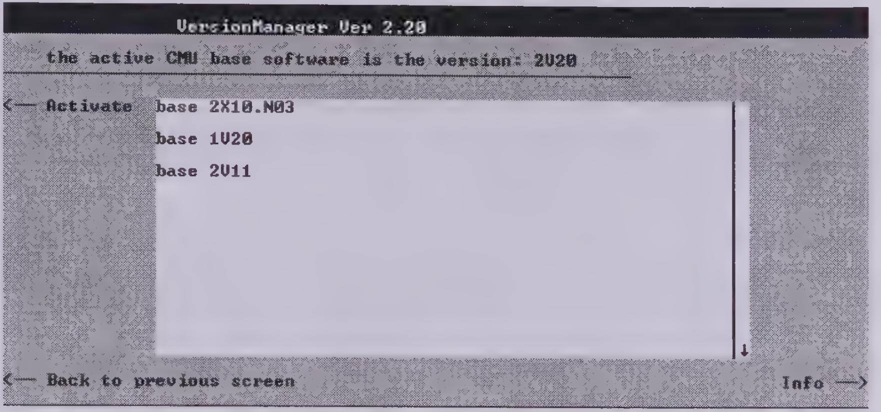


```
                 VersionManager Ver 2.20
   the active CMU base software is the version: 2020

<-- Activate other software                   Write log files to disk -->
<-- Delete software                          Delete non volatile ram -->
<-- Install software from PC-card slot 0                    Scan disk -->
<-- List software                           List all versions to disk -->
<-- Firmware update after board change  Copy non volatile ram to disk -->
<-- Edit service tables                                Defragment disk -->
<-- Exit                                                          Info -->
```

Fig. 1-9 VersionManager main screen (example)

The different functions of the *VersionManager* are activated by pressing the corresponding softkeys. Some of them (labeled optional below) are available in a particular configuration of the hard disk only. The upper two softkeys in both softkey bars are not assigned.

Activate other software (optional)	*Activate other software* opens a list of all firmware configurations stored on the CMU hard disk except the current configuration. Therefore, this function is not available if the hard disk contains only a single configuration (to retrieve information, *List software* can be used instead).



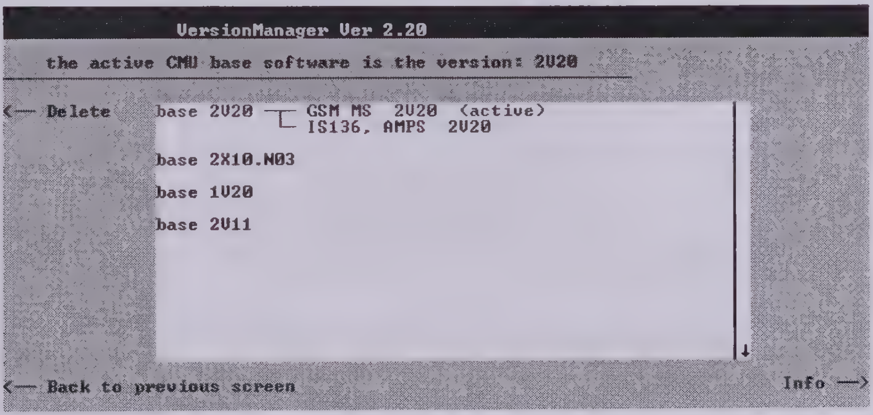
```
VersionManager Ver 2.20
the active CMU base software is the version: 2V20

base 2X10.N03
base 1V20
base 2V11
```

Each entry in the list corresponds to a firmware configuration consisting of exactly one CMU base software version (top level on the left side) plus a set of associated options[1] (network tests, second level). The version to be activated is displayed in red color on top of the list. To select another version, the list can be scrolled using the rotary knob or the cursor keys.

Activate	Activate the current firmware configuration.
Back to previous screen	Close the current screen and go back to the main screen. This option is identical in all *VersionManager* submenus.
Info	Open the *Info* screen associated to the current screen; see *Info on* p. 1.24. This option is identical in all *VersionManager* submenus.

Delete software (optional)

Delete software opens a list of all firmware configurations stored on the CMU hard disk. The dialog can be operated as explained above; see *Activate software.* The last firmware configuration can not be deleted, so this function is not available if the hard disk contains only a single configuration.



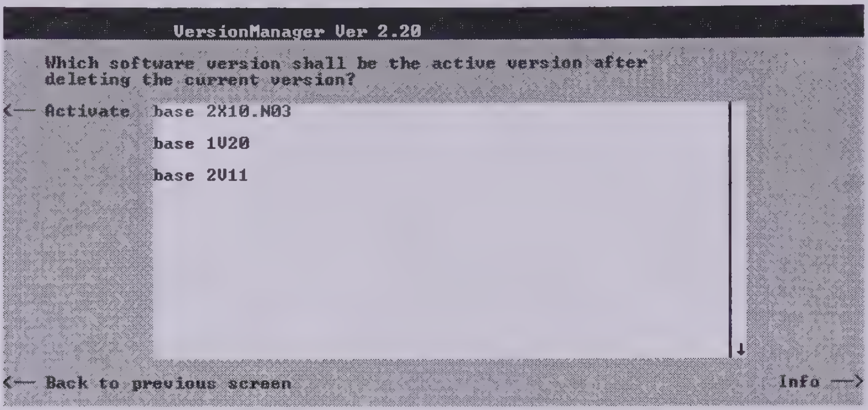
```
VersionManager Ver 2.20
the active CMU base software is the version: 2V20

base 2V20 ─┬ GSM MS   2V20  (active)
           └ IS136, AMPS   2V20
base 2X10.N03
base 1V20
base 2V11
```

Delete	Delete the current firmware configuration.

If the active firmware configuration is deleted, the CMU asks which of the remaining versions shall be activated:

---

[1] Several related options may be displayed in a single line. These combinations of options can be installed together and will be simply referred to as "options" through the remainder of this section.



Which software version shall be the active version after deleting the current version?

Activate Activate the current firmware configuration.

Install software... *Install software...* opens a list of all firmware installation versions available on an external storage medium (floppy disk/PCMCIA card). As explained in Table 1-1, this function depends on the type and number of storage media and on the number of installation versions available.

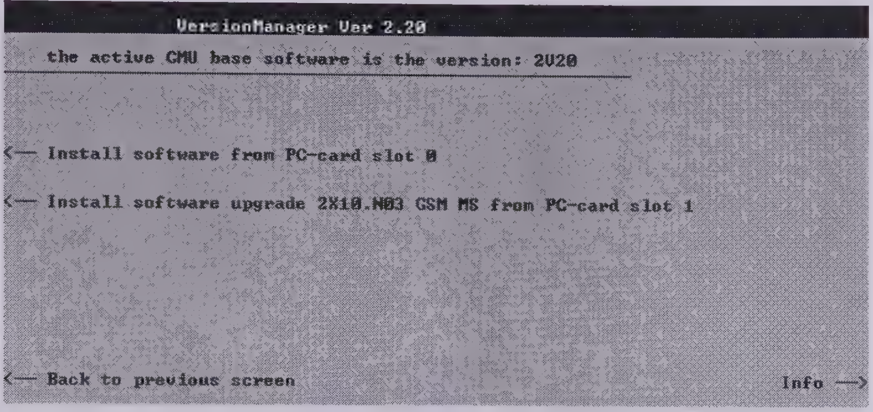
Table 1-1 Software installation with the *VersionManager*

Storage medium with FW installation version[2]	Number of FW installation versions	VersionManager function
Floppy	1	*Install software version <version> from floppy*
	several	*Install software from floppy* –> Open software version selection dialog (see below).
PCMCIA card in slot 0 or 1 (left or right side)	1	*Install software version <version> from PC-card slot <slot_no>*
	several	*Install software from PC-card slot <slot_no>* –> Open software version selection dialog (see below).
PCMCIA card in slot 0 and in slot 1	1 (per PC-card)	*Install software version <version> from PC-card* –> Open PC-card selection dialog (see below).
	several	*Install software from PC-card* –> Open PC-card selection dialog (see below).

PC-card selection dialog: The *PC-card* selection dialog selects either PCMCIA card slot 0 (left side) or slot 1 (right side) for installation.

---

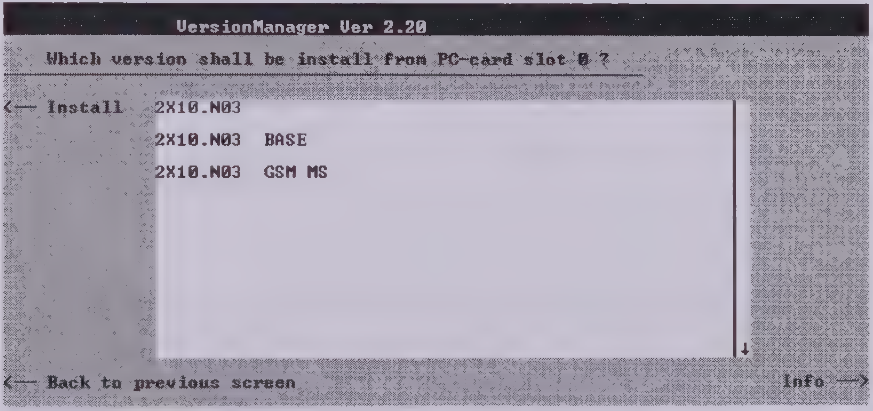
[2] Media witout FW installation versions are ignored.



```
VersionManager Ver 2.20
the active CMU base software is the version: 2V20

<— Install software from PC-card slot 0

<— Install software upgrade 2X10.N03 GSM MS from PC-card slot 1

<— Back to previous screen                                    Info —>
```

Install software... Select the card in slot 0 or slot 1 as an installation medium. If the medium contains several installation versions, the *software version* selection dialog is called up, see below.

Software version selection dialog: The *software version* selection dialog lists all installation versions on the current medium (floppy, PCMCIA card). The dialog can be operated as explained above; see *Activate software.*

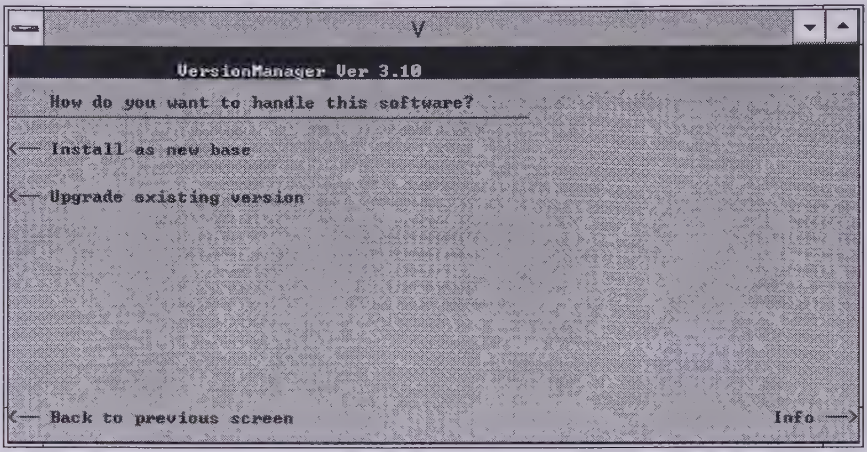


```
VersionManager Ver 2.20
Which version shall be install from PC-card slot 0 ?
<— Install    2X10.N03
              2X10.N03  BASE
              2X10.N03  GSM MS

<— Back to previous screen                                    Info —>
```

Install Install the current firmware version.

Upgrade options: In contrast to the *Activate software* dialog, the software selection dialog handles base software versions and network options separately. As a consequence, different versions of the base software can be combined with different options to create new firmware configurations. For example, it is possible to update the base software without affecting the associated network options or vice versa. Moreover, the same base software version can be installed several times and combined with different network options (and vice versa), so it may enter into several firmware configurations. The following simple rules apply:

- With a new version of a network option, it is only possible to update one of the existing configurations. The following selection dialog is automatically skipped.
- With a new base software version, it is possible to either update an existing configuration or create a new one. A dialog selecting between the two alternatives is opened:

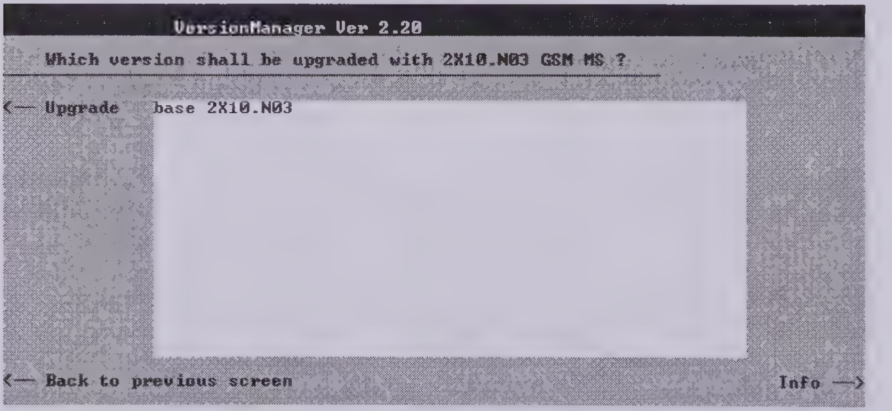

V
VersionManager Ver 3.10

How do you want to handle this software?

<— Install as new base
<— Upgrade existing version
<— Back to previous screen
Info —>

Note:	*This dialog is skipped if the new base software version is not compatible with any of the existing configurations. An incompatible new base software must be installed as a new base software.*
Install as new base	Create a new configuration based on the base software to be installed. The upgrade selection dialog described below is skipped. Network options can be assigned to this base software in a second stage of the installation.
Upgrade existing v.	Select an existing configuration and replace the base software of this version. To this end, the upgrade selection dialog described below is opened.

After selection of an upgrade software version compatible with one of the configurations stored on the hard disk, the upgrade selection dialog is called up:


VersionManager Ver 2.20

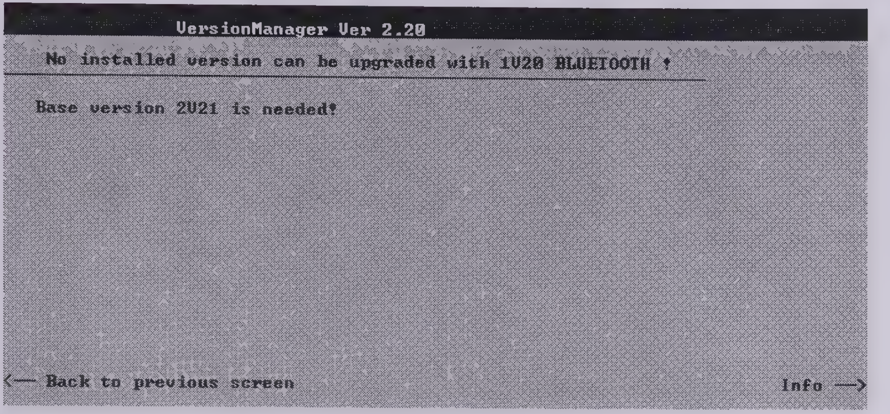
Which version shall be upgraded with 2X10.N03 GSM MS ?

base 2X10.N03

<— Upgrade
<— Back to previous screen
Info —>

Upgrade	Replace the base software version or network option selected in the *software version* selection dialog.

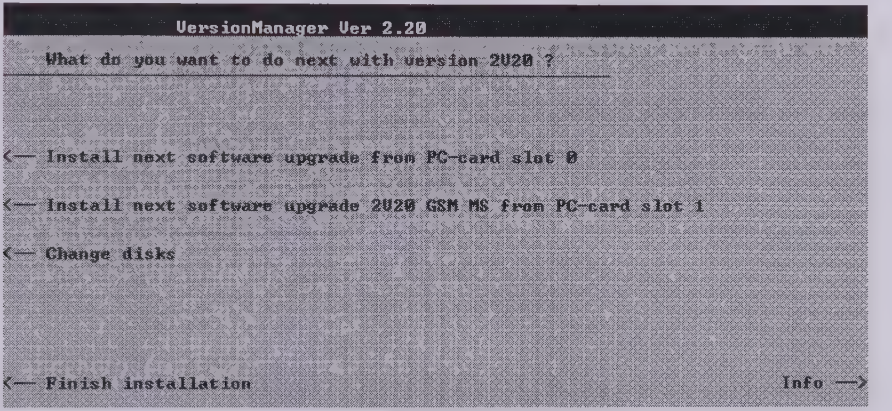
Alternatively, if none of the configurations stored on the hard disk is compatible with the software version selected, the following error message is displayed:


VersionManager Ver 2.20
<— Back to previous screen
Info —>

```
No installed version can be upgraded with 1V20 BLUETOOTH !

Base version 2V21 is needed!
```

Back to...	Close the current screen and go back to the *software version* selection dialog to select a compatible software version.

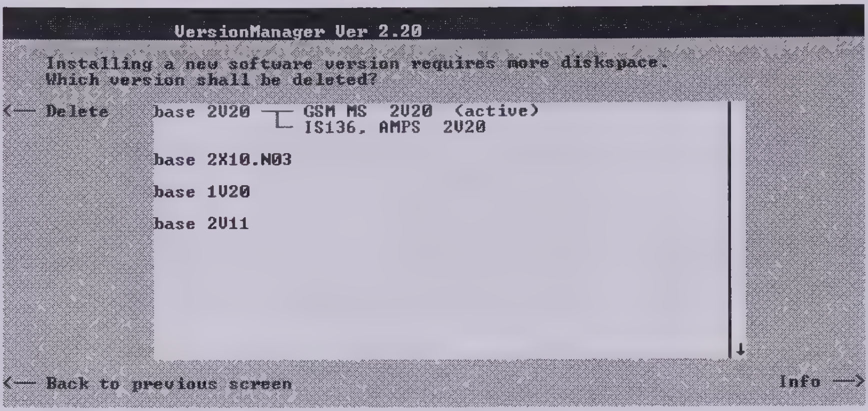
Terminating the software update: After successful installation of each software version the CMU displays the following screen:


VersionManager Ver 2.20
<— Install next software upgrade from PC-card slot 0
<— Install next software upgrade 2V20 GSM MS from PC-card slot 1
<— Change disks
<— Finish installation
Info —>

```
What do you want to do next with version 2V20 ?
```

Install next software...	Go back to the *software version* selection dialog to select additional software modules to be installed in the same *VersionManager* session. This function depends on the storage media and the number of software installation versions available; see Table 1-1 on page 1.19.
Change disks	Update the current screen after a change of the storage medium.
Finish installation	Close the *VersionManager* and reboot the CMU (remove the external disk from the disk drive). The installed firmware configurations are then operational. The last configuration installed is taken as the active configuration in the subsequent measurement session.

Lack of disk space: Before installing the next software version, the CMU checks whether there is enough disk space on the hard disk. If not, the following dialog is displayed:

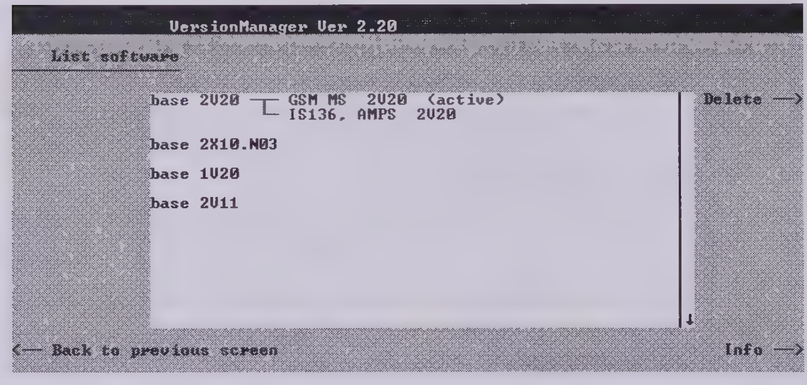


```
VersionManager Ver 2.20
Installing a new software version requires more diskspace.
Which version shall be deleted?
<— Delete     base 2V20 ─┬─ GSM MS   2V20  (active)
                         └─ IS136, AMPS  2V20
              base 2X10.N03
              base 1V20
              base 2V11
<— Back to previous screen                              Info —>
```

Delete	Delete the current version and return back to the previous screen.

List software

List software opens a list of all available firmware configurations. It is possible to activate and delete configurations from the list; see description of *Activate software* and *Delete software* functions above.



```
VersionManager Ver 2.20
List software
          base 2V20 ─┬─ GSM MS  2V20  (active)          Delete —>
                     └─ IS136, AMPS  2V20
          base 2X10.N03
          base 1V20
          base 2V11
<— Back to previous screen                              Info —>
```

Firmware update after board change

Firmware update after board change performs an update of the current firmware including a complete CMU hardware detection. No external installation disk is required.

The update takes some time and should be attempted in case of problems or after a modification of the CMU hardware configuration only (also after a combined hardware/software exchange).

Edit service tables

Edit service tables calls up the *Service Table Editor* menu showing all hardware modules that are possibly fitted in your instrument. For service purposes, further information can be obtained by typing a particular board name and board index in the two lines below the table.

Exit

Exit closes the *VersionManager* and resumes the CMU start-up procedure.

Write log files to disk

Write log files to disk copies all *.log files stored on the CMU hard disk to an external storage medium (floppy or PCMCIA card). The *.log source files on the hard disk are not deleted.

The *Write log files to disk* function opens a blue message box indicating the storage capacity of the external disk needed. The *.log files can be distributed over several disks. If no disk is available, the *VersionManager* displays a warning and does not start copying.

Delete non volatile ram

Delete non volatile ram deletes all entries stored in the non volatile ram of the CMU. This memory contains particular settings of the last CMU session that are to be reused in the next session (e.g. the last active function group and measurement menu, special configuration etc.).

Deleting the non volatile ram can be useful after an abnormal termination of a CMU measurement session.

Scan disk

Scan disk closes the *VersionManager,* executes the MS *Scan Disk* program and finally returns you to the *VersionManager.* Refer to your *Scan Disk* documentation for further information.

Note: *This function is not available while a base software version <V3.00 is active.*

List all versions to disk

List all versions to disk writes the software configurations indicated via *List software* to an ASCII text file that is stored on the external disk.

Copy non volatile ram to disk

Copy non volatile ram to disk copies the contents of the non volatile ram to the external disk (floppy, PCMCIA).
In this way, the settings stored in the non volatile ram can be used on another CMU.

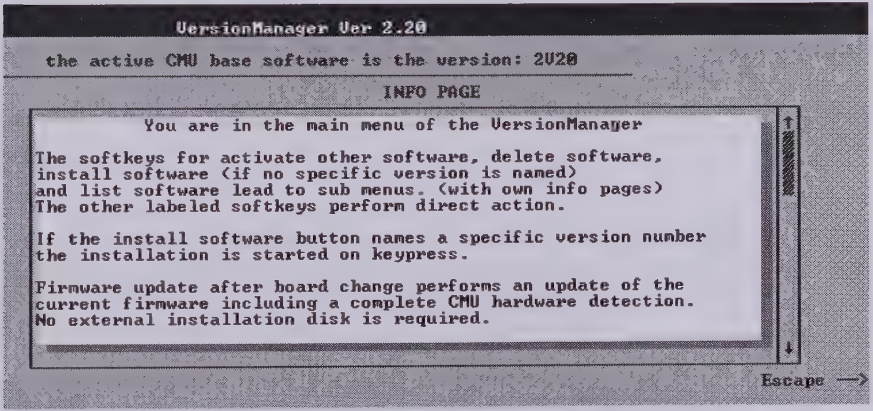
Defragment disk

Defragment disk closes the *VersionManager,* executes the MS *Defrag.exe* program and finally returns you to the *VersionManager.* Defragmenting the hard disk is suitable to improve performance after installing and deleting many different software versions. Refer to your *Defrag.exe* documentation for further information.

Note: *This function is not available while a base software version <V3.00 is active.*

Info

Info opens an output window displaying information on the current screen. Separate *Info* windows are provided for the different *VersionManager* dialogs.



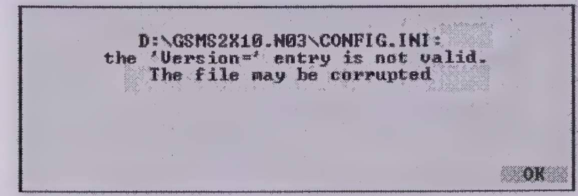
```
                 VersionManager Ver 2.20
  the active CMU base software is the version: 2V20
                                   INFO PAGE
          You are in the main menu of the VersionManager

 The softkeys for activate other software, delete software,
 install software (if no specific version is named)
 and list software lead to sub menus. (with own info pages)
 The other labeled softkeys perform direct action.

 If the install software button names a specific version number
 the installation is started on keypress.

 Firmware update after board change performs an update of the
 current firmware including a complete CMU hardware detection.
 No external installation disk is required.
```

Escape Close the Info screen and return to the previous screen.

Error and notify message

During operation, the *VersionManager* can display two different types of messages:

- Error messages indicating that an action could not be successfully performed are displayed in yellow boxes. All error messages with possible reasons and remedial actions are explained in Chapter 9 of this manual.



```
D:\GSMS2X10.N03\CONFIG.INI:
the 'Version=' entry is not valid.
The file may be corrupted
```

- Notify messages describing ongoing processes of the instrument are displayed in blue boxes. These messages are self-explanatory and do not require an action to be taken by the user.

Contents

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  How to access and close menus 2.2
  How to use dialog elements in the menus 2.3

Startup of the CMU **2.4**

RF Non Signalling Measurements **2.8**

2 Getting Started

The following chapter presents a sample session with the universal radio communication tester CMU. It is intended to provide a quick overview of the settings provided in the base system and the *RF* function group. No specific device under test is required. For an introduction to mobile network tests (e.g. tests of GSM900/1800/1900 mobile phones) please refer to the relevant operating manuals.

Before starting any measurement with the CMU, please note the instructions given in chapter 1 for putting the instrument into operation. In chapters 2 to 4 you will find detailed information on customizing the instrument and the display according to your personal preferences.

The steps to perform are explained on the left side of each double-page together with the results obtained on the CMU screen. On the right side, additional information is given. We also point out alternative settings and related measurements which could not be reported in detail.

For a systematic explanation of all menus, functions and parameters and background information refer to the reference part in chapter 4.

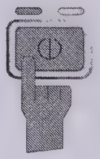
A Short Tutorial on CMU Operation

The principles of manual operation – controls, operating menus, dialog elements and measurement control – are discussed in chapter 3. Below we list some essentials for first users:

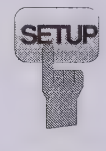
Condensed Operating Instructions

1. When using CMU for the first time it is useful to set it to the default state (*RESET* hardkey).
2. *ENTER* key: press even if "No" or "Yes" is displayed.
3. There is no Home menu but the *MENU SELECT* hardkey can be pressed in any state of the unit. A large popup menu is then displayed in which the function group (network etc.), signalling mode and measurement menus can be selected. Activate by pressing *ENTER*.
4. Which of the RF connectors is configured as output is indicated by a front-panel LED. In the menu, the generator can be activated or deactivated with *ON/OFF* (green/red). The LED goes out if the generator is in the *OFF* position.
5. Which of the RF connectors is configured as input is indicated by a front-panel LED. In the menu, the measurement can be controlled via the *ON/OFF* and *CONT/HALT* keys (*ON* (green), *OFF* (red) and *HLT* (yellow) states). In the *OFF* state, the LED goes out.
6. The *SETUP* hardkey allows to make static, measurement-independent default settings such as Remote or Time, to check which options are built in and to activate new software options.
7. The left softkey row is missing in the graphics menus. The softkeys on the right-hand side are used to change the meaning of the hotkeys (bottom). Pressing the MENUS softkey (bottom right) allows a fast switchover between related menus using the hotkeys.
8. Signalling does not necessarily have to be activated by means of a general menu; for example, the *Power* menu for GSM mobile tests can be called up immediately, without transferring any signalling information. The user is popup-menu guided (as default) through the different CMU signalling states (messages: switch mobile on, registered, call setup). This menu guidance via popup menu can be switched off.

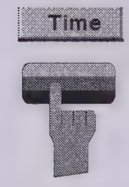
How to access and close menus



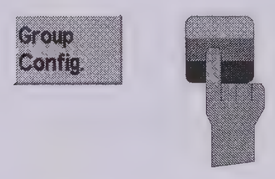
A startup menu is displayed automatically when the CMU is switched on.



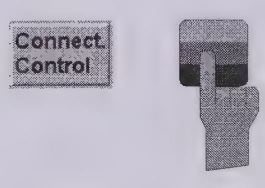
Some general configuration and selection menus can be opened via the *MENU SELECT, RESET, INFO, PRINT,* or *SETUP* keys on the front panel.



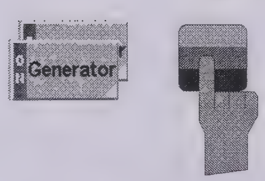
The hotkeys displayed across the bottom of a main menu or graphical measurement menu are used to switch over between different main menus or graphical measurement menus. Index cards in popup menus are also accessible via hotkeys.


Group Config.

The *Group Config.* softkey (always at the top left) is available in all measurement menus. After pressing this softkey all configurations of the current function group and signalling state can be carried out.



The *Connect. Control* softkey (always at the top right) is available in all measurement menus. After pressing this softkey, several index cards are available for setting the input/output, external attenuation, reference frequency (e.g. 10 MHz external) as well as further parameters.

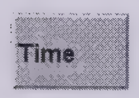


If a special configuration menu exists for a measurement or for a generator the corresponding softkey is marked with a yellow arrow. The configuration menu is opened by pressing the softkey twice.

All small and large CMU popup menus can be closed with the ESCAPE *ESCAPE* key.

Main menus and graphical measurement menus are closed on switching to another main or graphical measurement menu.

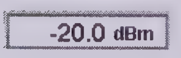
How to use dialog elements in the menus



The dialog elements assigned to a softkey are selected by pressing the softkey.

Different entry fields can be selected by means of the 4 cursor keys (blue frame shows active entry field).

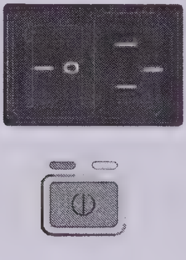
One of several elements in a list or toggle switch can be selected with the rotary knob.



Numeric values can be either incremented/decremented using the rotary knob or entered via the numeric keypad.

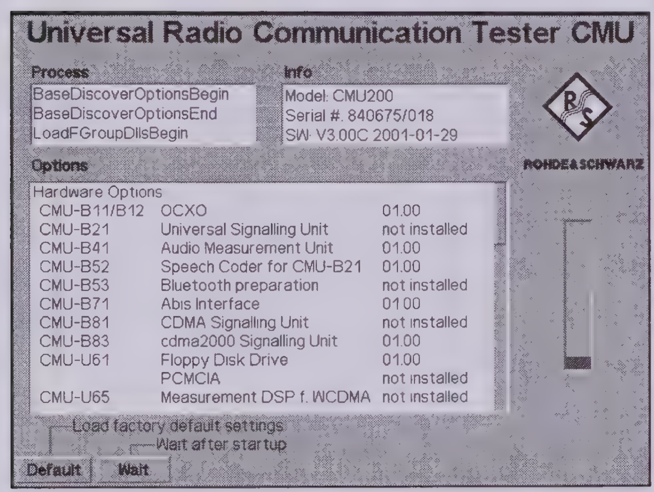
Startup of the CMU

This chapter describes how to customize the CMU and perform simple RF measurements. As a prerequisite for starting the session, the instrument must be correctly set up and connected to the AC power supply as described in chapter 1.



Step 1

- ➢ Switch on the CMU using the mains switch at the rear. ①
- ➢ Check the operating mode of the instrument at the *ON/STANDBY* key on the front panel. If the CMU is in standby mode, press the *ON/STANDBY* key. ②



Universal Radio Communication Tester CMU

Process
BaseDiscoverOptionsBegin
BaseDiscoverOptionsEnd
LoadFGroupDllsBegin

Info
Model: CMU200
Serial #. 840675/018
SW: V3.00C 2001-01-29

Options

Hardware Options		
CMU-B11/B12	OCXO	01.00
CMU-B21	Universal Signalling Unit	not installed
CMU-B41	Audio Measurement Unit	01.00
CMU-B52	Speech Coder for CMU-B21	01.00
CMU-B53	Bluetooth preparation	not installed
CMU-B71	Abis Interface	01.00
CMU-B81	CDMA Signalling Unit	not installed
CMU-B83	cdma2000 Signalling Unit	01.00
CMU-U61	Floppy Disk Drive	01.00
	PCMCIA	not installed
CMU-U65	Measurement DSP f. WCDMA	not installed

Step 2

The CMU is booted and after a short while displays the startup menu. This menu is usually closed as soon as the instrument software is loaded and the startup test is finished. ③

- ➢ Press the *Wait* hotkey to prevent the instrument from switching to another menu. ④

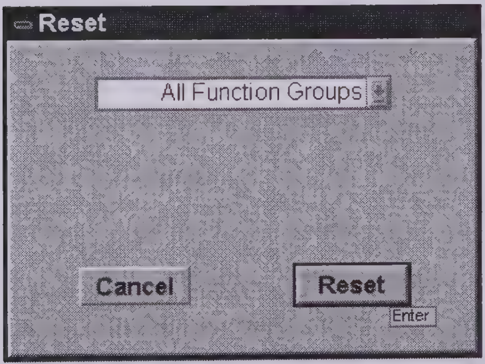
The *Wait* hotkey changes to *Cont.* with the additional message *Change to last menu* displayed on top.

- ➢ Press the *Cont.* hotkey to resume the startup process.

Step 3

- ➢ Press the *RESET* key.

The *Reset* popup menu is opened.



- ➢ Use the left and right arrow keys to toggle between the two buttons *Cancel* and *Reset*.
- ➢ Select *Reset* and press the *ENTER* key.
- ➢ In the popup window opened *(Are you sure?)*, select *Yes* to confirm the instrument reset.

The CMU indicates that it performs a general reset of all device settings and is then ready to carry out the following steps. The *Reset* popup menu is closed automatically.

Additional Information...

... on Step 1

① **Mains switch on the rear panel**

When the mains switch at the rear is set to the *O* position, the complete instrument is disconnected from the power supply. When the mains power switch is set to the *I* position, the instrument is in standby mode or in operation, depending on the position of the *ON/STANDBY* key on the front panel.

② **ON/STANDBY key on the front panel**

The *ON/STANDBY* key at the front of the instrument determines whether the instrument is in standby mode or in operation.

Standby mode:
Only the OCXO reference frequency oscillator (option CMU-B11/B12), if installed, is supplied with operating voltage. The orange LED (STANDBY) is illuminated.

Operation:
The green LED (ON) is illuminated and all modules of the instrument are supplied with operating voltage.

... on Step 2

③ **Startup menu**

The startup menu displays the following information:

- The startup procedure (Process)
- Instrument model, serial number and version of the CMU base software (Info).
- Installed hardware and software options and equipment (Options). Available software options are listed with their version numbers.
- Progress of the startup procedure (Startup bar graph).

④ **Wait hotkey**

By default the CMU switches to the last main menu of the previous session after terminating the startup process. This is convenient if an interrupted session is to be resumed or if the instrument is generally used in a definite operating mode.

On the other hand, the *Wait* function can be used to access the configuration menus which can be opened by means of the front panel keys before the actual measurement is started.

While the *Wait* hotkey is active, a reset of the instrument is not possible.

Alternative Settings and Measurements

☞ chapter 1

The CMU is automatically set to the AC supply voltage and frequency applied. Note the permissible ranges of AC voltages and frequencies indicated at the rear of the instrument and in the data sheet.

☞ chapter 1

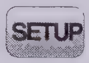
☞ chapter 4, p. 4.1

The *Default* hotkey can be used to load the factory default settings for all function groups. Settings made and stored in the previous session are overwritten.

The CMU's user interface has been optimized with the aim of facilitating fast and easy switchover between the menus and measurement modes. This includes the general configurations which can be accessed from any measurement menu.

The most important selection and configuration menus such as *Reset, Setup, Menu Select* are directly accessible via front panel keys.

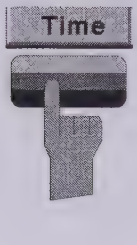
⇓



Step 4

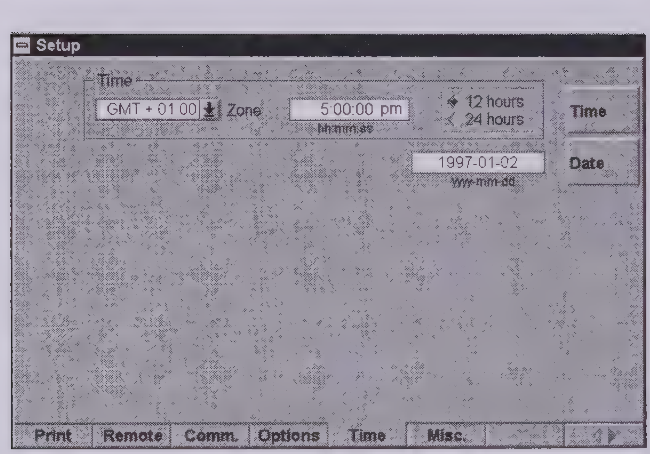
- Press the *SETUP* key to access general device settings.

⇓



- Press the *Time* hotkey to switch over to the *Time* index card of the *Setup* menu. ①

⇓



Time

GMT + 01:00 Zone

5:00:00 pm hh:mm:ss

● 12 hours
○ 24 hours

1997-01-02 yyyy-mm-dd

Step 5

The *Time* index card of the *Setup* menu displays the current time zone, time and date. ②

- Press the *Time* softkey to modify the settings for the current time.
- Use the left ⇦ and right ⇨ arrow keys to access the three control elements.
- After selecting the *Zone* pull-down list, turn the rotary knob to expand the list and select one of the entries.
- After selecting the time input field press the *ENTER* key to edit the hours, minutes and seconds separately.
- After selecting the *12 hours/24 hours* command buttons use the rotary knob to switch over between European and North American time conventions.

Additional Information...

... on Step 4

① **Softkeys and hotkeys**
Softkeys and hotkeys are activated by pressing the associated keys on both sides and across the bottom of the display. The general purpose of softkeys is to provide settings, control the generator and the measurements. Hotkeys are used to switch over between different menus and different index cards belonging to a popup menu.

... on Step 5

② **Setup menu**

The *Setup* menu comprises several index cards providing general instrument settings. It is advisable to check and adjust the factory settings when you operate the CMU for the first time.

To switch over between the index cards of the setup menu use the hotkeys displayed at the bottom of the display.

Alternative Settings and Measurements

☞ chapter 3

☞ chapter 4, p. 4.6

The different types of menus and control elements of the graphical user interface is explained in chapter 3. In the same chapter you can find a short tutorial on the entry of numbers and characters.

RF Non Signalling Measurements

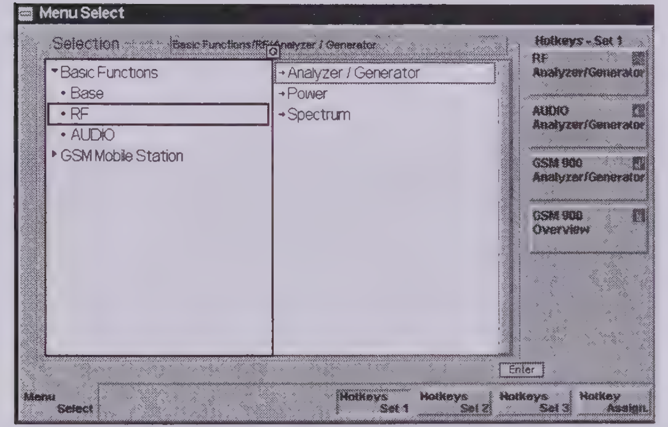
In the *RF Non Signalling* mode, a continuous or pulsed RF signal can be generated and a RF signal with definite frequency characteristics can be analyzed. The signal level can be plotted in oscillographical *(Power versus Time)* or spectral *(Spectrum)* representation.

MENU
SELECT

Step 1

- ➢ Press the *Menu Select* key to open the *Menu Select* menu.①

⇓


Menu Select
Selection
Basic Functions/RF/Analyzer / Generator
Basic Functions
Base
RF
AUDIO
GSM Mobile Station
Analyzer / Generator
Power
Spectrum
Hotkeys - Set 1
RF Analyzer/Generator
AUDIO Analyzer/Generator
GSM 900 Analyzer/Generator
GSM 900 Overview
Enter
Menu Select
Hotkeys Set 1
Hotkeys Set 2
Hotkeys Set 3
Hotkey Assign.

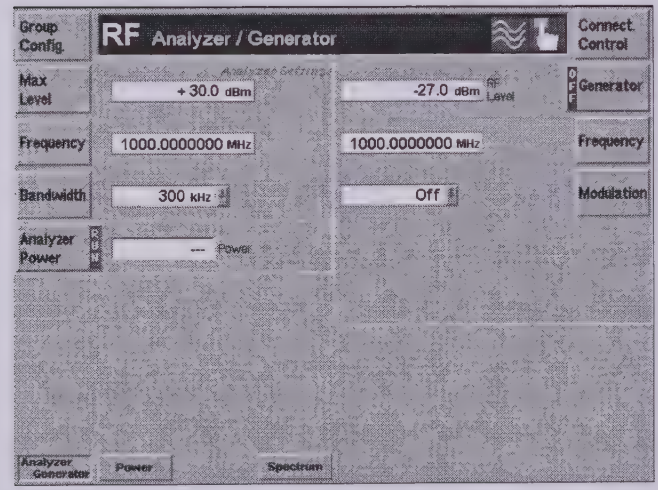
- ➢ Use the cursor keys and the rotary knob to select the *RF* function group in the left half of the *Selection* table.

The *Non Signalling* mode is indicated and highlighted in the *Mode* field.

- ➢ In the right half of the table, select the *Analyzer/Generator* menu.
- ➢ Press the *Enter* key to activate the measurement selected and open the *RF Analyzer/Generator* menu.

⇓

Step 2


Group Config.
RF Analyzer / Generator
Connect. Control
Analyzer Settings
Max Level
+30.0 dBm
-27.0 dBm
RF Level
Generator
Frequency
1000.0000000 MHz
1000.0000000 MHz
Frequency
Bandwidth
300 kHz
Off
Modulation
Analyzer Power

Power
Analyzer Generator
Power
Spectrum

The *Analyzer/Generator* menu indicates the parameters of the signal generated and those of the signal received and analyzed by the CMU. ②

At present, all parameters are set to factory default values. They can be changed directly in the *Analyzer/Generator* menu. User-defined parameters will be saved for later sessions when the CMU is switched off.

- ➢ Select the *Generator* softkey by pressing once.
- ➢ Press the *ON/OFF* key to switch the RF generator on and off again. ③
- ➢ Set the generator frequency equal to the analyzer frequency as shown in the figure.

⇓

Additional Information...

Alternative Settings and Measurements

... on Step 1

① **Menu Select menu**

The *Menu Select* menu shows all function groups installed on your CMU. If a function group is selected the corresponding modes and measurement menus are indicated. Function groups representing digital network tests (such as GSM400/900/1800/1900-MS) are generally subdivided in the two measurement modes *Non Signalling* and *Signalling*, each containing a number of measurement menus.

RF measurements are performed in the *Non Signalling* mode with the three measurement menus *Analyzer/Generator*, *Power vs. Time* and *Spectrum.* All three measurement menus can be directly accessed from the *Menu Select* menu.

☞ chapter 4, p. 4.4

For digital network tests refer to the relevant operating manuals. e.g. GSM400/900/1800/1900-MS.

... on Step 2

② **Analyzer/Generator menu**

The *Analyzer/Generator* menu contains two configuration panels used for

- control of signals received and analyzed by the CMU *(Analyzer Settings*, left side of the menu),
- control of signals generated *(Generator*, right side).

Defining a level and frequency in the *Generator* panel implies that a continuous signal with this level and frequency is generated.

The *Max. Level* defined in the *Analyzer* panel, however, denotes the maximum input power which can be measured. At the same time, it defines the upper limits of the *Power versus Time* diagram (see below). The permissible range of *Max. Level* depends on the input connector and external attenuation used (see section *Input Level* in chapter 4).

Defining a (center) frequency in the *Analyzer Settings* panel implies that only signals around this frequency are analyzed.

The *Bandwidth* softkey defines the resolution bandwidth of the analyzer.

☞ chapter 4, p. 4.18

The *Generator* panel is equivalent to the *Signal* tab of the *Connection Control* menu.

The *Generator* softkey opens the *Generator Configuration* popup menu providing further signal settings.

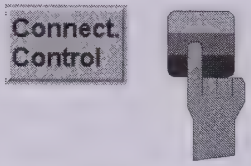
③ The status of the *Analyzer Power* measurement and of the RF Generator is shown besides the corresponding softkeys. For ongoing measurements, the result in the *Analyzer Power* output field is constantly updated.

At present no input signal is available so that the *Analyzer Power* output field shows no result "– – –"

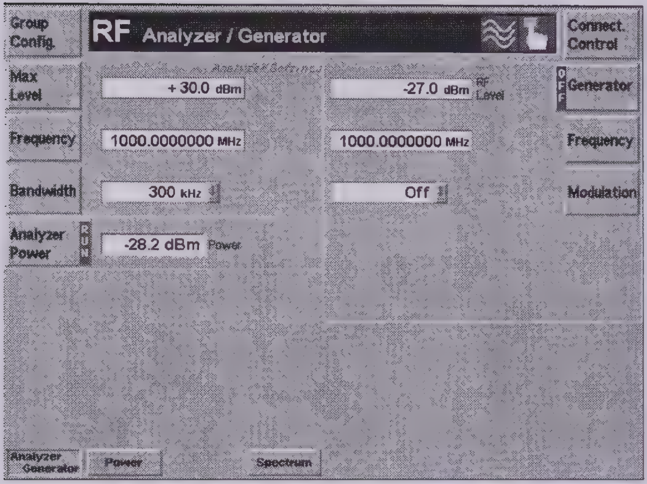
Once selected, the *Analyzer Power* measurement is switched off and on again by means of the *ON/OFF* key. In contrast, the *CONT/HALT* toggle key stops the measurement only after a valid result could be obtained.

☞ ch. 4, p. 4.18 and ch. 5

The options for the measurement status are *ON, OFF, or HLT*. The *HLT* applies particularly to single shot measurements (see the section about measurement control in chapter 5).


Connect.
Control

- Press the *Connect. Control* softkey.


Group Config.
RF Analyzer / Generator
Connect. Control
Analyzer Settings
Generator
Frequency
Modulation
Analyzer Generator
Power
Spectrum

Max Level +30.0 dBm

Frequency 1000.0000000 MHz

Bandwidth 300 kHz

Analyzer Power -28.2 dBm Power

RF Level -27.0 dBm

Frequency 1000.0000000 MHz

Modulation Off

Generator OFF

⇓

Step 3

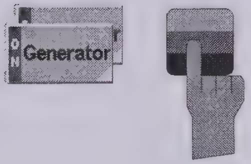
The *RF Connection Control* menu is opened. ①

- Press the *RF* ⊖ hotkey to open the index card defining the signal connectors and external attenuations.
- Select RF2 as output connector, RF4 IN as input connector. Do not define any external attenuations (all values equal to 0.0 dB).

Two yellow LEDs on the front panel indicate the input and output connectors selected.

- Use a coax cable to connect RF2 to RF4 IN.
- Press the *ESCAPE* key to close the popup menu and return to the *RF Analyzer/Generator* main menu.
- In the main menu, press the *Max. Level* softkey and set the maximum input level to 20 dBm.
- Switch on the RF Generator.

The RF level measured is indicated next to the *Analyzer Power* softkey. Due to the loss in the signal path it can be slightly below the generator power selected. ②


ON
Generator

⇓

- Press the *Generator* softkey twice.

The *Generator* Configuration popup menu is opened.

- Select the *Hopping* index card, use the rotary knob to select the *Ramping* parameter, press *Enter* and use the rotary knob again to switch the power ramping *ON*.

Now the generator transmits a pulsed (instead of a continuous) signal.

- Press the *Generator* softkey again or the *ESCAPE* key to close the popup menu.

Additional Information...

... on Step 3

① **RF connectors**

The *RF Connection Control* menu configures the input and output connectors in the *RF* function group. The four connectors on the front panel differ by their permissible range of input and output powers (see chapter 4 and data sheet). The values quoted on the left side are compatible with the rated specifications.

② **External attenuation**

An external attenuation can be reported to the CMU in order to compensate for known losses between the signal source and the device under test or the analyzer.

In our example, the (positive) difference between the analyzer power measured and the generator power can be reported as an external output attenuation at RF 2. The RF generator increases its level to maintain the commanded power of –27 dBm at the analyzer. The nominal generator power set in the RF level field is thus measured and indicated next to the *Analyzer Power* softkey.

Alternative Settings and Measurements

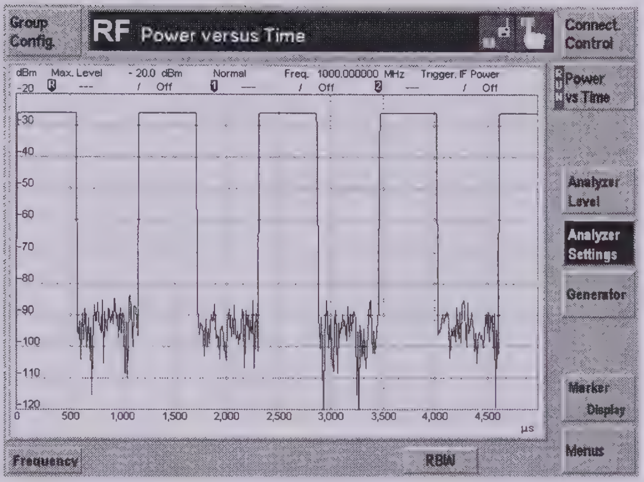
☞ chapter 4, p. 4.40

Settings made in *the Group Config.* and *Connect. Control* menus apply to the entire function group *RF Non Signalling*.

☞ chapter 4, p. 4.41

Note that an external attenuation reported to the CMU shifts the nominal permissible ranges of input and output levels.

Power


Group Config.
RF Power versus Time
Connect. Control
RUN Power vs Time
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
Frequency
RBW
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
µs

dBm Max. Level - 20.0 dBm Normal Freq. 1000.000000 MHz Trigger. IF Power
R --- / Off 1 --- / Off 2 --- / Off

Step 4

- ➢ Press the *Power* hotkey to switch over to the graphical menu *Power versus Time.*

The *Power versus Time* menu shows the RF signal power measured as a function of time at a particular frequency and resolution bandwidth. An appropriate trigger condition must be selected to obtain a stable display. ①

Settings (default settings or the ones made in the *Analyzer/Generator* menu) and scalar results are displayed in two parameter lines above the diagram.

Various tools allowing to take a closer look at the measurement results are provided in the graphical measurement menu. ②

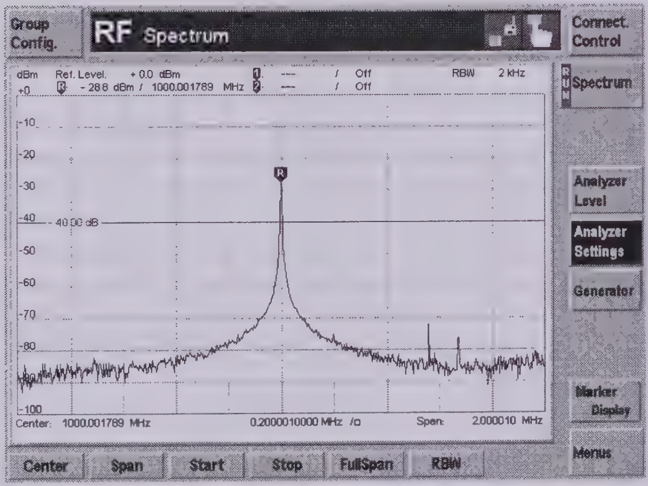
- ➢ Press the *Marker/Display* softkey twice and vary the *Time Scale* to display several pulses in the diagram.
- ➢ Press the *Analyzer Settings* softkey and vary the resolution bandwidth (hotkey *RBW).* ③
- ➢ Press the *Menu* softkey to display the hotkeys used to change over to the other measurement menus.
- ➢ Press the *Spectrum* hotkey to switch over to the graphical menu *Spectrum.*

⇓

Spectrum

⇓

Step 5

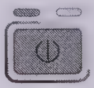

Group Config.
RF Spectrum
Connect. Control
RUN Spectrum
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
+0
-10
-20
-30
-40
-50
-60
-70
-80
-100
R
40.00 dB
Center 1000.001789 MHz
0.2000010000 MHz /□
Span 2.000010 MHz
Center
Span
Start
Stop
FullSpan
RBW

dBm Ref. Level. + 0.0 dBm 1 --- / Off RBW 2 kHz
R - 28.8 dBm / 1000.001789 MHz 2 --- / Off

The *Spectrum* menu shows the signal power in spectral representation, i.e. as a function of the frequency.

The settings and results displayed in the two parameter lines above the diagram are analogous to the ones shown in the Power versus Time menu.

- ➢ Press the *Marker* softkey and use the *R to Pk* and the *Cnt to R* hotkeys to center the diagram. ④
- ➢ Press the *Analyzer Settings* softkey to scale the diagram and adjust the resolution bandwidth.
- ➢ To close your session set the CMU to standby mode using the power switch on the front panel or use the mains switch at the rear.



Additional Information...

... on Step 4

① **Trigger mode**

The trigger mode is set in the *Group Configuration* popup menu or via the *Trigger* softkey in the graphical measurement menus. With the default setting *Free Run* the measurement is not synchronized to the frequency of the incoming pulses: The trace is permanently shifted in horizontal direction.

To show a signal consisting of rectangular pulses (bursts) it is recommended to trigger by either the rising or falling edge of the IF power.

② **Markers**

Markers are a graphical tool used to locate points on a trace and read out their coordinates. A reference marker and two delta markers may be defined in the *Power versus Time* menu.

The reference marker R measures the absolute level of the trace, the delta markers 1 and 2 measure the distance between their position and the reference marker. All marker coordinates are shown in the two parameter lines above the diagram.

③ **Resolution bandwidth**

A spectrum analyzer can differentiate two spectral lines separated by a minimum distance corresponding to the bandwidth of the resolution filter.

The smaller the bandwidth the better the resolution and the larger the signal-to-noise ratio. If the resolution bandwidth is too large only the envelope of the spectrum can be measured.

In the *Power versus Time* measurement, the signal-to-noise ratio improves but the time resolution **deteriorates** when the resolution bandwidth is reduced.

... on Step 5

④ **Scaling of the spectral diagram**

The tools provided in the *Spectrum* menu are particularly suitable for scaling a spectral diagram with a sharp main lobe and symmetric, lower side lobes:

- The *R to Pk* hotkey (*Marker* softkey) places the reference marker to the maximum (i.e. the main lobe) of the diagram.
- The *Cnt to R* hotkey (*Marker* softkey) centers the diagram to the frequency of the main marker.
- Equivalently, the *Center* hotkey *(Frequency/RBW* softkey) can be used to center the diagram.

Alternative Settings and Measurements

☞ chapter 4, p. 4.45

The *Frequency* softkey defines the frequency of the measured signal and the resolution bandwidth. The *Input Level* softkey configures the input level, the power range and an attenuation factor. The *Time* softkey configures the time axis.

☞ chapter 4, p. 4.24

In addition to markers, a D-line can be used to measure a particular level in the diagram.

☞ chapter 4, p. 4.24

☞ chapter 4, p. 4.32

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3 Manual Operation

This chapter provides a survey of the CMU's operating concept. This includes a description of the basic menu types, the selection and setting of parameters, and a general discussion of measurement control. The operating menus in the CMU basic system, the *RF* function group, and optional function groups are presented in an overview at the end of this chapter and described in greater detail in chapter 4.

Operating concept The CMU was designed for easy, intuitive operation. All menus rely upon a limited number of controls with analogous or identical function. Basic settings are discussed in section *Measurement Control* on page 3.17 and in chapter 5.

Basic elements The CMU is operated via softkeys and tables. Softkeys provide a fast access to the instrument functions. Tables facilitate the management of larger amounts of data.

Flexibility and uniformity The CMU permits to switch over between various operating modes (multi-mode operation). For this purpose, it is possible to change between the menus in almost any instrument state. The different function groups (*RF, GSM900/1800/1900* etc., see also separate operating manuals for network test applications) can be operated in the same way; measurements of the same type belonging to different applications are standardized.

Controls

The CMU is operated under menu control via keys, softkeys and hotkeys:

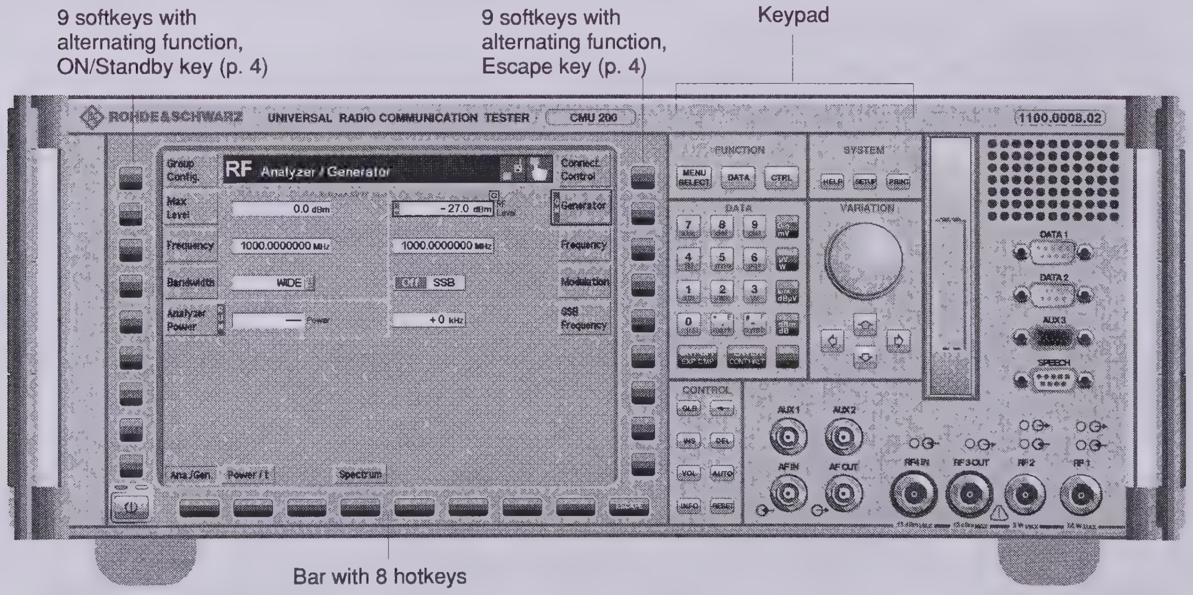

9 softkeys with alternating function, ON/Standby key (p. 4)
9 softkeys with alternating function, Escape key (p. 4)
Keypad
ROHDE&SCHWARZ
UNIVERSAL RADIO COMMUNICATION TESTER
CMU 200
1100.0008.02
RF Analyzer / Generator
Bar with 8 hotkeys

Fig. 3-1 Keys, softkeys and hotkeys

Rotary Knob

The rotary knob (spinwheel) can be used in two different ways:

- It is turned to select entries in list fields and tables and to vary (increment/decrement) numerical and alphanumerical entries.
- It is pressed to expand or compress table sections (thus replacing the *ON/OFF* key), to expand pull-down lists, to open auxiliary input fields, and to confirm numerical entries or selections (thus replacing the *ENTER* key).

Keys

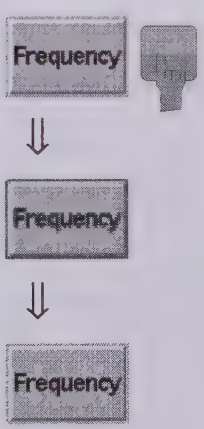
The keys located in the right-hand part of the front panel are combined to form groups according to their functions. They control

- Data input and variation
- Pre-selection of the menus
- Settings of the instrument, editor, help file and output

The keys are described with their function in chapter 1, section *Front and Rear View*.

Softkeys

Softkeys are assigned to the nine keys located both at the left and at the right edge of the screen. To simplify the display, only the softkeys which are actually assigned in a menu are indicated (see menu example in Fig. 3-1).



Selection of softkeys:

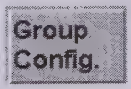
The CMU provides selectable and non-selectable softkeys. A softkey is selected by pressing the associated key.

A selected softkey is highlighted by a blue frame. The selection establishes a connection to settings and functions related to the softkey. These related functions can be initiated via keys (e.g. *ON/OFF, CONT/HALT),* or via the selected softkey itself (e.g. calling up popup menus).

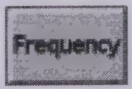
After the function has been terminated, or after another softkey is selected, the softkey returns to its initial state.

Softkey types and their function:

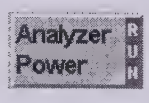
Softkeys perform functions within the corresponding menus. Different types of softkeys are provided:



- Pressing the softkey (i.e. the associated key) causes an immediate response on the screen. Examples are the non-selectable softkeys used to call up popup menus.

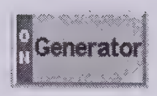


- Pressing the softkey activates a dialog box, e.g. an input field.



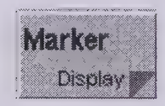
- The softkey indicates the measurement state (*RUN, OFF, HLT*). A yellow triangle indicates that a popup menu providing configurations can be opened with the softkey (press once for selection, a second time for opening the popup).

  A measurement can be started and aborted with the *ON/OFF* key (i.e. the ON/OFF key switches between the measurement states *RUN* and *OFF*). It can be stopped while preserving the valid results with the *CONT/HALT* key (i.e. the *CONT/HALT* key switches between the measurement states *RUN* and *HLT;* starting a measurement from the *OFF* state by means of the *CONT/HALT* key is not possible). In the *HLT* state, the instrument resources are not released; the application is still available. The formal aspects of measurement control are explained in chapter 5.



- The softkey indicates the generator status *(ON, OFF)*. A yellow triangle indicates that a popup menu providing configurations can be opened with the softkey (press once for selection, a second time for opening the popup).

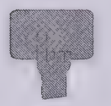
  A generator can be started and aborted with the *ON/OFF* key. The formal aspects of generator control are explained in chapter 5, section *Measurement Control*.



- The softkey toggles between two hotkey bars (corresponding to two groups of settings). The current group is indicated in large typeface in the first line of the softkey; the alternative group appears in smaller typeface next to a double triangle.

Hotkeys

Hotkeys are assigned to the eight keys at the lower edge of the screen. Only the hotkeys softkeys which are actually assigned in a menu are indicated (see Fig. 3-1).



Selection:

A hotkey is activated by pressing the associated key. After activation it changes its frame.

Function:

Hotkeys permit to

- Change from one main menu/graphical measurement menu to the other
- Select tabs in the popup menu or table menu

In the graphical measurement menu (see page 3.6), hotkeys provide extended settings and can be used like ordinary function softkeys.

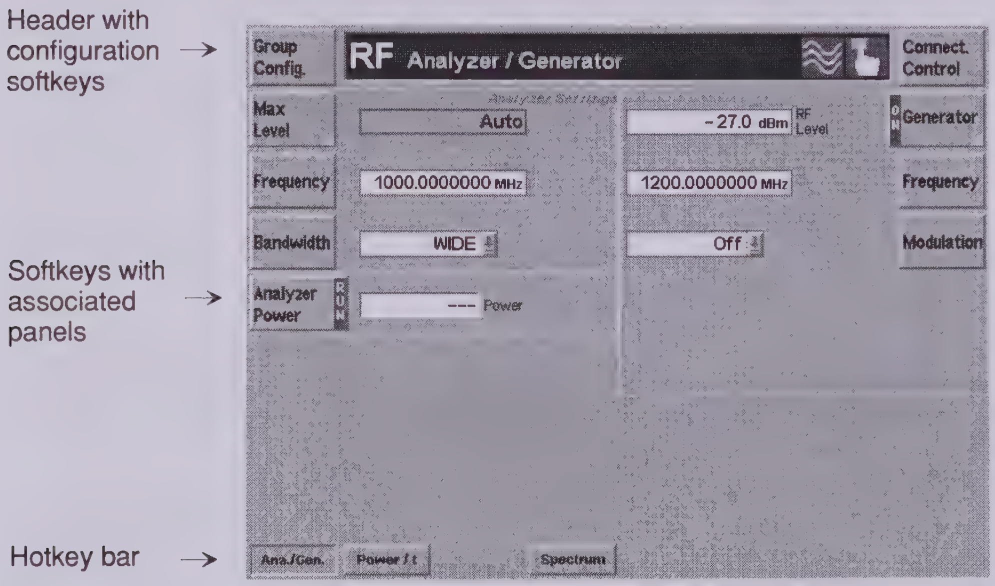
Operating Menus

The CMU offers a large variety of operating modes and applications. To ensure quick and easy operation, uniform menus have been implemented. They can be divided into three types:

Main menu	Offers the main settings controlling a measurement and displays the main results,
Popup menu	Provides extended settings for a main menu or function group,
Graphical menu	Displays a measurement trace together with settings and further measurement results, contains softkeys and hotkeys used to access measurement control settings.

Main Menus

A main menu provides the basic settings controlling a measurement and at the same time displays the main results. Together with the graphical measurement menus, main menus constitute the basic level in the operating system of the CMU. They can only be replaced by other main menus or graphical measurement menus. To change the menu, the hotkeys at the lower edge of the main menu are used.


Header with configuration softkeys →

Softkeys with associated panels →

Hotkey bar →

Max Level: Auto

Frequency: 1000.0000000 MHz

Bandwidth: WIDE

Analyzer Power: --- Power

RF Level: -27.0 dBm

Generator Frequency: 1200.0000000 MHz

Modulation: Off

Fig. 3-2 Example of a main menu

Header The header consists of the heading and the symbols for the operating mode and signalling state.

- The *heading* briefly describes the menu subject (e.g. type of settings, measurement group, function group, etc.)
- The *operating mode*, i.e. the type of operation/control of the CMU, is indicated by the symbols at the right edge of the header. The following operating modes are available:

Manual mode

Remote control via IEC-bus

- The *function group* is indicated to the left of the operating mode:

≋ RF measurements

In network test applications, the *signalling states* that are specific to the applications are indicated. The corresponding icons are discussed in the relevant manuals (see *GSM900/1800/1900-MS* etc.).

Test configurations

Group Config.

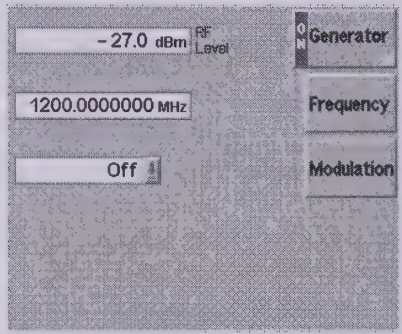
The *Group Config.* softkey is located to the left of the header of each main or graphical measurement menu. It opens a popup menu, which can be used for global configuration of the different measurements in the current *function group* and *signalling state.*

Connect. Control

The *Connect. Control* softkey is located to the right of the header of each main or graphical measurement menu. It opens a popup menu, which is used to configure the inputs and outputs for the current *function group* and *signalling state* and further parameters such as network and signalling parameters (if applicable).

Softkeys with panels

A group of controls of a main menu with related function is generally combined in a panel.



A panel contains (at least) one softkey with associated input and display windows. The *main softkey* of a panel (if available) is the one that is located on top and displays the state of a measurement or a generator.

Hotkey bar

The max. 8 hotkeys at the lower edge of the main menu permit to change the menu. The hotkey bar is identical for all main menus within a function group so that blind operation is possible.

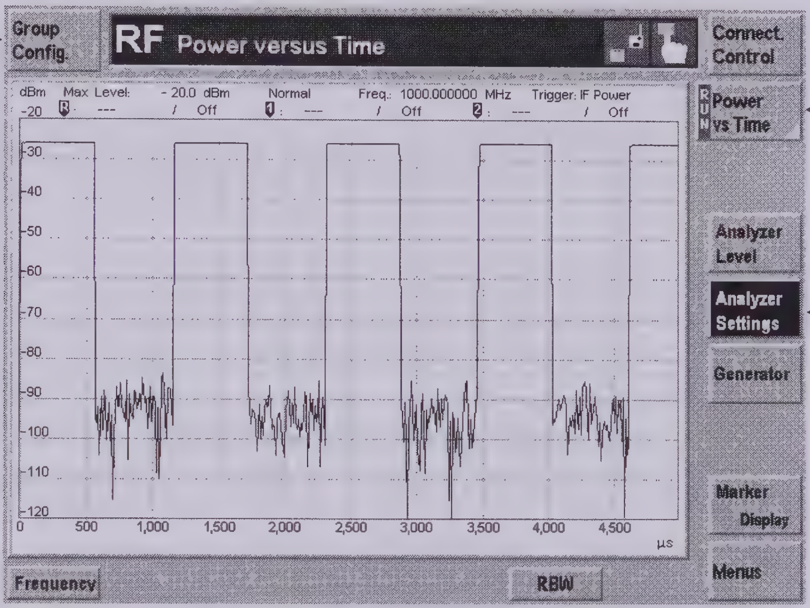
Graphical Measurement Menus

The CMU displays arrays of measurement results in the form of two-dimensional diagrams. In order to obtain additional space for the test diagram, the left softkey bar is suppressed. The right softkey bar can not always offer a sufficient number of functions and configurations, so the hotkeys are also used for menu operation. Further configuration settings can be accessed via popup menus.

Header with configuration softkeys →

Test diagram →

Hotkeys for "Frequency/RBW" configuration →


Group Config.
RF Power versus Time
Connect. Control
dBm Max Level: - 20.0 dBm Normal Freq.: 1000.000000 MHz Trigger: IF Power
-20 R: --- / Off 1: --- / Off 2: --- / Off
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
0 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 4,500
µs
RUN
Power vs Time
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
Frequency
RBW

← Main softkey

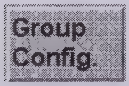
← Active softkey

Fig. 3-3 Example of graphical measurement menu

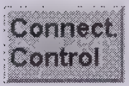
Header The header consists of the heading and the symbols for the function group and the signalling state.

- The *heading* briefly describes the menu subject (e.g. type of settings of the measurement, designation of the function group, etc.)
- The *signalling state*, i.e. the type of operation/control of the CMU, is indicated by symbols at the right edge of the header. See section *Main Menus* on page 3.4.

Test configurations

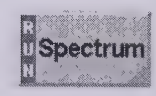

Group Config.

The *Group Config.* softkey is located to the left of the header of each main or graphical measurement menu. It opens a popup menu, which can be used for global configuration of the different measurements in the current *function group* and *signalling state.*

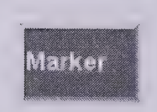

Connect. Control

The *Connect. Control* softkey is located to the right of the header of each main or graphical measurement menu. It opens a popup menu, which is used to configure the inputs and outputs for the current *function group* and *signalling state* and further parameters such as network and signalling parameters (if required).

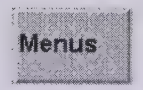
Softkeys



The main softkey of a graphical measurement menu is located directly below the *Connect. Control* softkey. Its labeling corresponds to the menu heading. The main softkey controls the measurement and indicates its state. In the example of Fig. 3-3 a popup menu is available for this purpose.

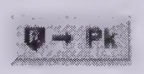


The function softkeys below the main softkey activate the associated hotkey bar. An active function softkey is displayed in inverse video.



The *Menus* softkey changes the hotkey bar to the menu-changing mode.

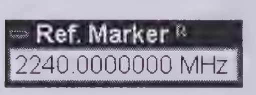
Hotkeys



In the function mode, i.e. if one of the function softkeys is activated, the hotkeys below the test diagram provide sub-functions for the respective softkey.

In the menu-changing mode, i.e. if the *Menus* softkey is activated, the hotkeys change between the various measurement groups of the current function group.

Popup window



Ref. Marker

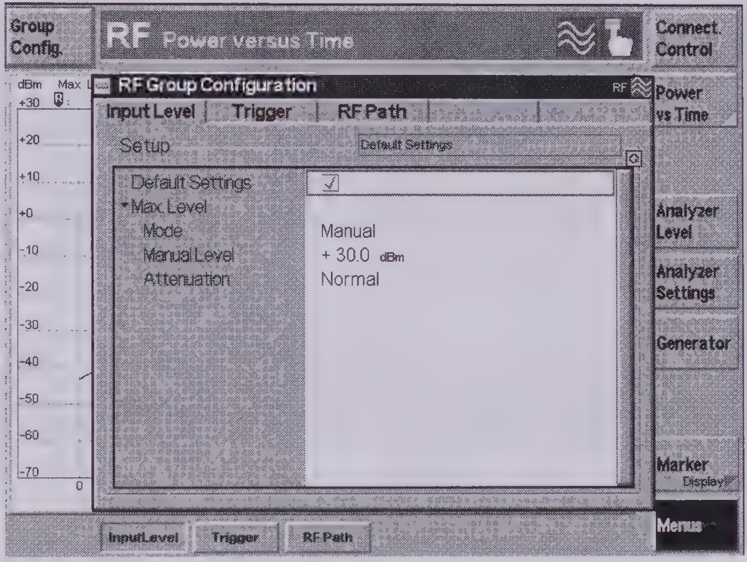
2240.0000000 MHz

Popup windows are associated to all hotkeys that require the selection or input of parameters. These popup windows are operated like input fields in the main menus (input of numbers and characters) or list fields (selection between a range of alternative settings).

Popup Menus

Popup menus extend the functions of a main menu. They are available with the configuration softkeys *Group Config.* and *Connect. Control* as well as with all softkeys in a main menu that are marked by a yellow triangle at the bottom right. They may be divided into several tabs that are selected via hotkeys in the main menu.

The popup menus *Group Configuration* and *Connection Control* are activated by pressing the respective softkeys. Popup menus which configure a measurement are activated by pressing the respective softkey twice (selection of softkey and subsequent opening of popup menu). A popup menu is closed by means of the *ESCAPE* key or by pressing the calling softkey again.


Group Config.
RF Power versus Time
Connect. Control
RF Group Configuration
RF
Input Level
Trigger
RF Path
dBm
Max
+30
+20
+10
+0
-10
-20
-30
-40
-50
-60
-70
0
Power vs Time
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
InputLevel
Trigger
RF Path

Setup: Default Settings

Default Settings	☑
▾Max Level	
Mode	Manual
Manual Level	+ 30.0 dBm
Attenuation	Normal

Popup menu with Header and two tabs →

Calling softkey, press twice

Hotkeys for selecting the tabs →

Fig. 3-4 Example of a popup menu

Header The header consists of

- The heading (*<name of the measurement group> Configuration*; the function group is indicated on the right in small characters),
- The symbol for the signalling state on the right. See section *Main Menus* on page 3.4.

Tabs Popup menus come without tabs (1 single window) or with several tabs (pages).

The tabs may contain input fields, select fields, command and on/off switches (checkboxes). Various fields can be combined to form groups (panels).

(Expanding) menu tables Configuration settings in popup menus are often arranged in tables. If a table provides a large number of settings, these are usually grouped under several header lines marked by a black triangle. The items belonging to a group can be shown (expanded, triangle points down) and hidden (compressed, triangle points to the right) by selecting the corresponding header line and pressing the *ON/OFF* key or the rotary knob.

Operation of Popup Menus

The following table provides an overview of the operation of popup menus.

Table 3-1 Operation of popup menus

Action		**Operation via keys**
Open menu		Press the softkey twice (selection plus opening of menu), press only once in the case of *Group Config.* and *Connect. Control*
Select	tabs dialog elements	Press hotkey softkeys *(Connect. Control)*, cursor keys ⇦⇨⇧⇩
Edit fields		Keys *ON/OFF, ENTER,* number and unit keys, rotary knob, see section *Dialog Elements in the Menu* on page 3.10.
Edit table entries		Keys ON/OFF, ENTER, number and unit keys, rotary knob, see section *Dialog Elements in the Menu* on page 3.10.
Quit and close menu		Any assigned softkey / *ESCAPE* key

Dialog Elements in the Menu

This section describes the various types of dialog fields and the procedure for the input of values and parameters.

Various input and select field types request a selection to be confirmed using the *ENTER* key. The cursor can be freely shifted over these fields; only after the confirmation is the setting transferred to the instrument software.

In the case of select fields without confirmation, settings are immediately made, they take effect with the cursor selection.

Input Fields

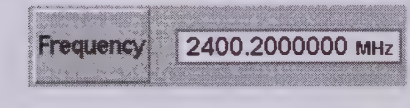
An input field (editor) is a white, rectangular area on the screen which permits numbers or characters to be entered. Input fields are available both in main and in popup menus. In graphical measurement menus, the input fields are popup windows which can be called up by means of hotkeys while the instrument is in the function mode.

Note: *The easiest and quickest way to enter numbers or characters is by means of an external keyboard that is connected to the* KEYBOARD *connector at the rear of the CMU (see chapter 1). Alternatively, follow the directions given in the next two sections.*

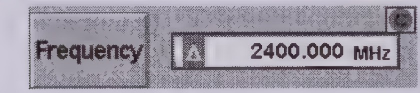
Input of Numbers

Input fields for numerical values are activated by pressing the respective softkey. Numerical values can either be varied using the rotary knob (by incrementing/decrementing individual digits) or directly entered via the numerical keypad *(DATA)* on the front panel or an external keyboard. To this end, the insert and overwrite mode is available. It may be necessary to confirm the input for transfer to the instrument hardware.

In the following, the most important possible inputs using the rotary knob or the numerical keys will be described.



Frequency 2400.2000000 MHz



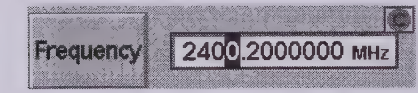
Frequency ▵ 2400.000 MHz

Activating an input field and a digit

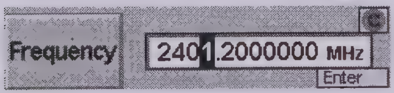
- ➢ To activate the input field press the associated softkey.

  The input field appears with a blue frame. The symbol for the rotary knob appears at the top right of the input field.

  The input field is in start mode, indicated by a small white triangle on a gray background. From the start mode, it can be switched to either insert or overwrite mode.



Frequency 2400.2000000 MHz



Frequency 2401.2000000 MHz

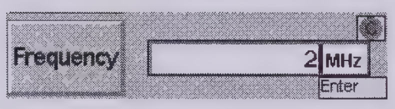
Input using the rotary knob – Overwrite mode

- ➢ In the start mode, turn the rotary knob to activate the overwrite mode and vary the last digit of the current number.
- ➢ Use the left ⇦ or right ⇨ *arrow key* to switch between the decimal places of the indicated number.
- ➢ Increment/decrement the active digit by turning the *rotary knob.*

  The individual digits can be varied without restriction. Incrementing a "9" produces 0 and causes the next higher digit to be incremented by 1. The editor behaves analogously when a “0“ is decremented.

An *Enter* symbol at the bottom right of the input field indicates that the current value has yet to be written to the CMU software.

- ➢ Confirm the entry and terminate the input using the *ENTER* key or by pressing the rotary knob or another softkey or ...
- ➢ Press *ESCAPE* to discard the entry.



Frequency 2 MHz

Input using the numerical keypad – Insert Mode

- ➢ In the start mode, type one of the number keys of the numerical keypad.

  The previous numeric value of the editor is completely replaced. The CMU changes to the insert mode characterized by a cursor symbol. Further digits are inserted to the left of the cursor.

- ➢ Entries made in insert mode via the numerical keypad must always be confirmed using the *ENTER* key or by pressing the rotary knob.

Further control keys

The keys of the *CONTROL* group extend the functions of numerical input.

- ➢ Use the INS *(insert)* key to change between the modes *insert* and *overwrite*.

  In the insert mode, the cursor appears in the input field.

- ➢ Use the ← *(backspace)* key to delete the character to the left of the cursor (in insert mode).
- ➢ Use the DEL *(delete)* key to delete the highlighted character (in overwrite mode) and the digit right from the cursor key (in insert mode).
- ➢ Use the CLR *(clear)* key to delete all characters.

Confirming/discarding the input

The behavior of the editors depends on whether the values were entered in the insert or in the overwrite mode:

- ➢ If only the overwrite mode was used to define the input value no confirmation is necessary. The input value is valid as soon as another softkey or hotkey is pressed.
- ➢ If the insert mode is used, or if it was used before swapping over to the overwrite mode, the input must be confirmed with the *ENTER* key or by pressing the rotary knob. By pressing *ESCAPE* or another softkey, the input will be discarded and the previous value restored.

If the number entered conflicts with the resolution of the CMU, it will be rounded to the maximum number of digits allowed.

Error message during input

If the value defined in the input field is too high or too low, a window with the error message „*<numerical value> is out of range. <permissible maximum value> is limit.*“ will appear together with three buttons:

Accept	Permissible maximum value accepted for input field,
Re-edit	New entry
Cancel	Last valid input value is retained.

Input of alphanumerical characters

Input fields for alphanumerical characters are activated by pressing the respective softkey. Characters can be either varied using the rotary knob (by variation of individual characters in alphabetical order) or entered via the numerical keypad *(DATA)* on the front panel or an external keyboard. The input must be confirmed using the *ENTER* key in order to be transferred to the instrument hardware. The input is terminated upon confirmation.

The table below shows the assignment of the numerical keys.

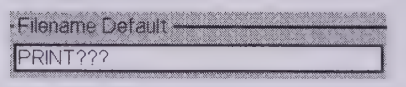
Table 3-2 Assignment of numerical keys and alphanumeric characters

Key	Character (upper case)	Character (lower case)
7 abc	A B C 7 Ä Æ Å Ç	a b c 7 ä æ å ç
8 def	D E F 8 É	d e f 8 é è
9 ghi	G H I 9	g h i 9 ì
4 jkl	J K L 4	j k l 4
5 mno	M N O 5 Ñ Ö	m n o 5 ñ ö ò
6 pqr	P Q R 6	p q r 6 ß
1 stu	S T U 1 Ü	s t u 1 ü ù
2 vwx	V W X 2	v w x 2
3 yz	Y Z 3	y z 3
0 _µΩ	space µ Ω 0 £ $ ¥ €	space µ Ω 0 £ $ ¥ €
. * mark	\ _ * , : ; ' " ? ( )	\ _ * , : ; ' " ? ( )
- # symb	- # / ( ) < = > % &	- # / ( ) < = > % &
UNIT.. ⇩	Upper / lower case	Upper / lower case

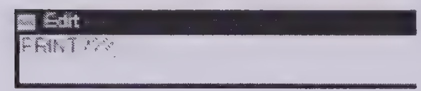
The full character set may be restricted if required for reasons of compatibility (e.g. for input fields defining file names).

The most important possible inputs using the rotary knob or the digital keys are described in the following.

Activating the input field and auxiliary editor



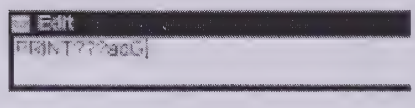
- ➢ To activate the input field press the associated softkey. If the softkey is assigned to a panel with several controls, use the cursor key to select the desired input field.



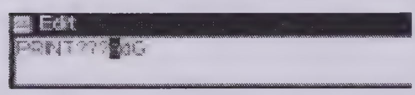
- ➢ Press or turn the rotary knob to open the auxiliary editor associated to the input field.

The auxiliary editor is used to edit a name that may extend over several lines. The cursor is placed at the end of the current character string.

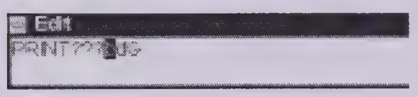
Input using the numerical keys



- ➢ Press one of the numerical keys to write a character to the current cursor position.



- ➢ To change a character, position the cursor to the desired character using the left ⇦ or right ⇨ *arrow key* and overwrite the character.

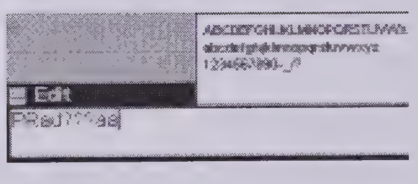


- ➢ Press a numerical key repeatedly to access the different characters assigned to it (see assignment of keys in Table 3-2).
- ➢ Press the *UNIT* key plus a numerical key to switch to the upper case character set.
- ➢ Confirm the input using the *ENTER* key.

If the syntax specified is invalid (e.g. an invalid file name was defined), an error message of the type *Filename syntax <name> is invalid Cancel / Re-edit* is displayed. Otherwise the edited character string is written to the input field in the menu.

- ➢ Press another softkey or change the menu to close the auxiliary editor.

Input using the rotary knob



- ➢ After opening the auxiliary editor, turn the rotary knob in either direction. A list of all valid (upper and lower case) characters for the current input field is opened.
- ➢ Turn the rotary knob and select the character to be written to the cursor position in the auxiliary editor. Selected characters are shown in inverse video.
- ➢ Press the rotary knob to confirm your selection and enter the selected character into the auxiliary editor.
- ➢ Select a character and turn the rotary knob to increment/decrement the character in alphabetical order.

Insert/overwrite

The keys of the *CONTROL* group extend the functions of character input.

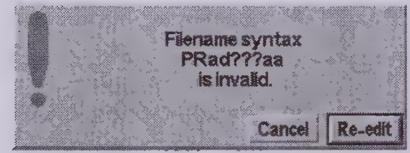
- ➢ Use the INS *(insert)* key to change between the modes *insert* and *delete*.

In insert mode, the cursor appears in the input field.

- ➢ Use the ← *(backspace)* key to delete the character to the left of the cursor.
- ➢ Use the DEL *(delete)* key to delete the inversely displayed character (in overwrite mode).
- ➢ Use the CLR *(clear)* key to delete all characters.

Confirming/discarding the input

- ➢ Use the *(ESCAPE)* key or another softkey to abort character input and deactivate the input field and the softkey.
- ➢ Use the CONT/HALT *(ENTER)* key to confirm the character input.



Filename syntax
PRad???aa
is invalid.

If the syntax specified is invalid (e.g. an invalid file name was defined), an error message of the type *Filename syntax <name> is invalid Cancel / Re-edit* is displayed. Otherwise the edited character string is written to the input field in the menu.

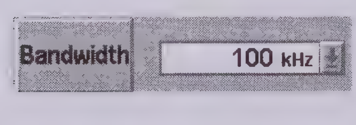
- ➢ Press another softkey or change the menu to close the auxiliary editor.

Select Fields

Various types of fields permit to select one or several settings out of a number of given options. The desired settings are to be marked; the selection is to be confirmed using the *ENTER* key, if required.

Select Fields in the Main Menu

Select fields in main menus are arranged in panels together with a softkey. Selection of the softkey activates the associated field for the selection.



Bandwidth 100 kHz

Pull-down lists

are marked by an arrow ↓ and select one out of n settings. The list of settings will appear in a pull-down window after the field is selected.

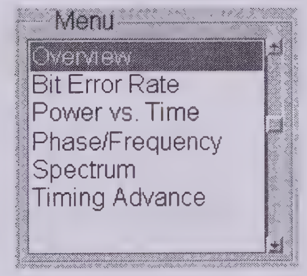
- ➢ Select the associated softkey to activate the select field and expand the list.
- ➢ To select one of the settings, use the rotary knob.
- ➢ Press *ENTER* to confirm your selection and close the list.
- ➢ Press *ESCAPE* or another key to discard your selection and close the list.

Select Fields in the Popup Menu

Popup menus may or may not contain softkeys; they contain input or select fields which can be combined to form panels or groups and tables. Select fields and tables in the popup menus can be controlled intuitively using the cursor keys ⇦⇨⇧⇩. The following overview applies to all field types.

Table 3-3 Operation of select fields

Action	Key operation
Select field group / list	Cursor keys ⇦⇨⇧⇩, softkey
Select single field, command button, or line in list field or table	Rotary knob
Switch on or off single field or line in list field	*On/Off* key, in the case of buttons also rotary knob, *ENTER* key
Confirmation (if required)	*ENTER* key

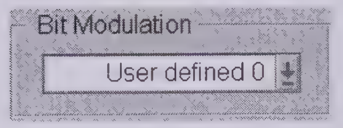


List fields (selection 1 out of n)

provide a choice of several text lines in a rectangular window:

- ➢ Select one out of several list fields using the cursor keys ⇦⇨⇧⇩.
- ➢ To select a line use the rotary knob. If a line beyond the edge of the list is to be selected, the whole list will be shifted (scroll function).

For operation of list fields see Table 3-3.

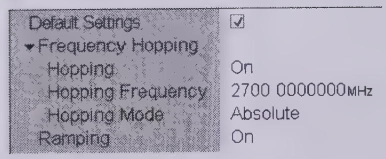


Bit Modulation: User defined 0

Pull-down list fields

are similar to the list fields described above as far as their function and operation is concerned; however, they are compressed into one line in the popup menu.

- ➢ Press the associated softkey (if available) or use the cursor keys ⇦⇨⇧⇩ to select the list. Press *ENTER* or the rotary knob to expand the list (expand in upward or downward direction depending on the space available).
- ➢ To select a line use the rotary knob.
- ➢ Press *ENTER* to confirm your selection and close the list.
- ➢ Press *ESCAPE* or another key to discard your selection and close the list.



Default Settings	☑
▾Frequency Hopping	
Hopping	On
Hopping Frequency	2700 0000000MHz
Hopping Mode	Absolute
Ramping	On

(Expanding) menu tables

usually cover the whole popup menu or tab so they are active as soon as the menu is opened. The right-hand fields of a menu table (white background) can be edited. Table lines without any input option but with a black triangle are headers with several sub-items that can be expanded or compressed:

- ➢ To move to a line use the rotary knob.

- Press *ENTER* to select a line and start editing. Numerical values can be entered as described in section *Input of Numbers* on page 3.10. Alternative settings can be selected using the rotary knob.
- Press *ENTER* to confirm an entry and release the table line.
- Press *ESCAPE* or another key to discard your entry and release the table line.
- Select a header line and press the rotary knob to expand (show) or compress (hide) a table section. Press the *ON/OFF* key to expand all compressed tables in the menu.

Measurement Control

This section gives a brief survey of the CMU's measurement control using the function group *RF Non Signalling* as an example. This includes a discussion of the different measurement modes and measured quantities. Settings and measurement parameters frequently encountered are explained from a general point of view.

The formal aspects of measurement control are discussed in more detail in chapter 5 *(Remote Control – Basics).*

The menus of the graphical user interface can be arranged in different ways. According to their tasks, they form the following groups:

- The function groups *RF, Audio, GSM900-MS, GSM1800-MS* and *GSM1900-MS*, etc. The *RF* function group is supplied with the firmware for the CMU base system. The function groups for network test applications are optional and described in separate operating manuals.
- The two signalling modes *Signalling* and *Non Signalling.* The signalling properties are specific to the individual networks and devices under test. In the function group *RF* only *Non Signalling* measurements are provided.
- General configurations *(Group Configuration, Connection Control),* configurations specific to a measured quantity *(Power vs Time Configuration, Spectrum Configuration*, etc.), and menus displaying the results of the measurement *(Power vs Time, Spectrum* etc.).

In a more formal sense, the CMU uses main menus, popup menus, table menus, and graphical measurement menus and dialog windows of various size. This aspect is discussed in the preceding sections.

Configurations

The CMU offers a wide range of settings for input and output signals and measurements. Configurations either refer to the whole function group *(Group Configuration, Connection Control)* or to a particular measurement.

Group Configuration

The *Group Config.* softkey is located on the left side of the title bar of each main menu and graphical measurement menu. It opens a popup menu with several tabs configuring

- The CMU receiver settings *(Input Level)*
- The trigger mode *(Trigger)*

All settings made in the *Group Config.* menu apply to the whole function group and test (signalling) mode. Most of them are also provided, however, in the graphical measurement menus. The *Group Config.* settings and the settings in the measurement menus overwrite each other.

Connection Control

The *Connect. Control* softkey is located on the right side of the title bar of each main and graphical measurement menu. It opens a popup menu with several tabs configuring

- The RF generator
- The RF connectors to be used and the external attenuation
- The reference signal and system clock

All settings made in the *Connect. Control* menu apply to the whole function group and signalling mode.

Configuration of measurements

A popup menu offering specific settings is assigned to each measurement group *(Power vs. Time and Spectrum).* The following parameters can be defined:

- The repetition mode and stop condition for the measurement
- Tolerances for the measured quantities
- Statistic count and display mode

Most of these settings are not needed in the device configuration menus and the *RF* function group discussed in this manual. For a detailed explanation refer to the manuals for network tests, e.g., *GSM900/1800/1900-MS.*

Measurement Groups

Measurement results are indicated in two different ways:

- Discrete (scalar) values and parameters are displayed in output fields, lists and tables.
- Traces are displayed in a Cartesian coordinate system, the time forming the x-axis scale.

While the measurement is running, the indicated results are constantly updated. Each function group and measurement mode comprises a particular selection of measurement groups. The measurement groups belonging to function group RF (Non Signalling) are shown in the following table.

Table 3-4 Measurements in function group *RF (Non Signalling)*

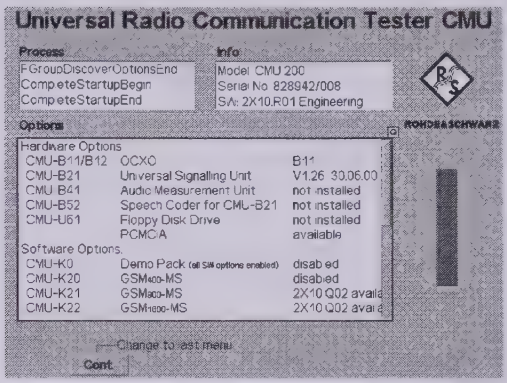
Menu	**Function**
Analyzer/Generator	Shows the settings for the signals generated and analyzed by the instrument, the generator status, and the state of the RF analysis. Moreover the current analyzer power is indicated.
Power vs Time	Shows the trace of the measured RF power in oscillographic representation, i.e. as a function of time. The maximum level and frequency of the input signal is indicated in addition. Single points of the trace may be evaluated using graphical tools (markers, D-Line).
Spectrum	Shows the trace of the measured RF power in spectral representation, i.e. as a function of the frequency. Parameters of the measurement are indicated in addition. Single points of the trace may be evaluated using graphical tools (markers, D-Line).

A graphical overview of the menus is given at the end of this chapter.

Menu Overview

CMU Base System – General Configurations

On Start-up:



Universal Radio Communication Tester CMU

Process
FGroupDiscoverOptionsEnd
CompleteStartupBegin
CompleteStartupEnd

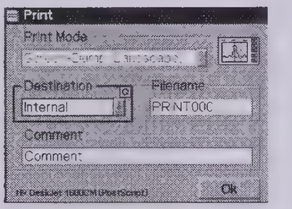
Info
Model CMU 200
Serial No 828942/008
SW: 2X10.R01 Engineering

Options

Hardware Options		
CMU-B11/B12	OCXO	B11
CMU-B21	Universal Signalling Unit	V1.26 30.06.00
CMU-B41	Audio Measurement Unit	not installed
CMU-B52	Speech Coder for CMU-B21	not installed
CMU-U61	Floppy Disk Drive	not installed
	PCMCIA	available
Software Options		
CMU-K0	Demo Pack (all SW options enabled)	disabled
CMU-K20	GSM_{400}-MS	disabled
CMU-K21	GSM_{900}-MS	2X10 Q02 availa
CMU-K22	GSM_{1800}-MS	2X10 Q02 availa

ROHDE&SCHWARZ
Change to last menu
Cont.

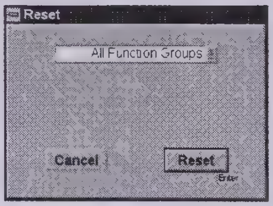
PRINT



Print
Print Mode
Destination: Internal
Filename: PRINT000
Comment: Comment

HP DeskJet 1600CM (PostScript)
Ok

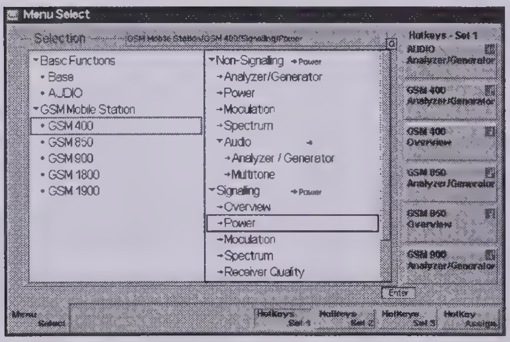
RESET



Reset
All Function Groups

Cancel
Reset
Enter

Menu Select



Menu Select
Selection: GSM Mobile Station/GSM 400/Signaling/Power

- Basic Functions
  - Base
  - AUDIO
- GSM Mobile Station
  - GSM 400
  - GSM 850
  - GSM 900
  - GSM 1800
  - GSM 1900

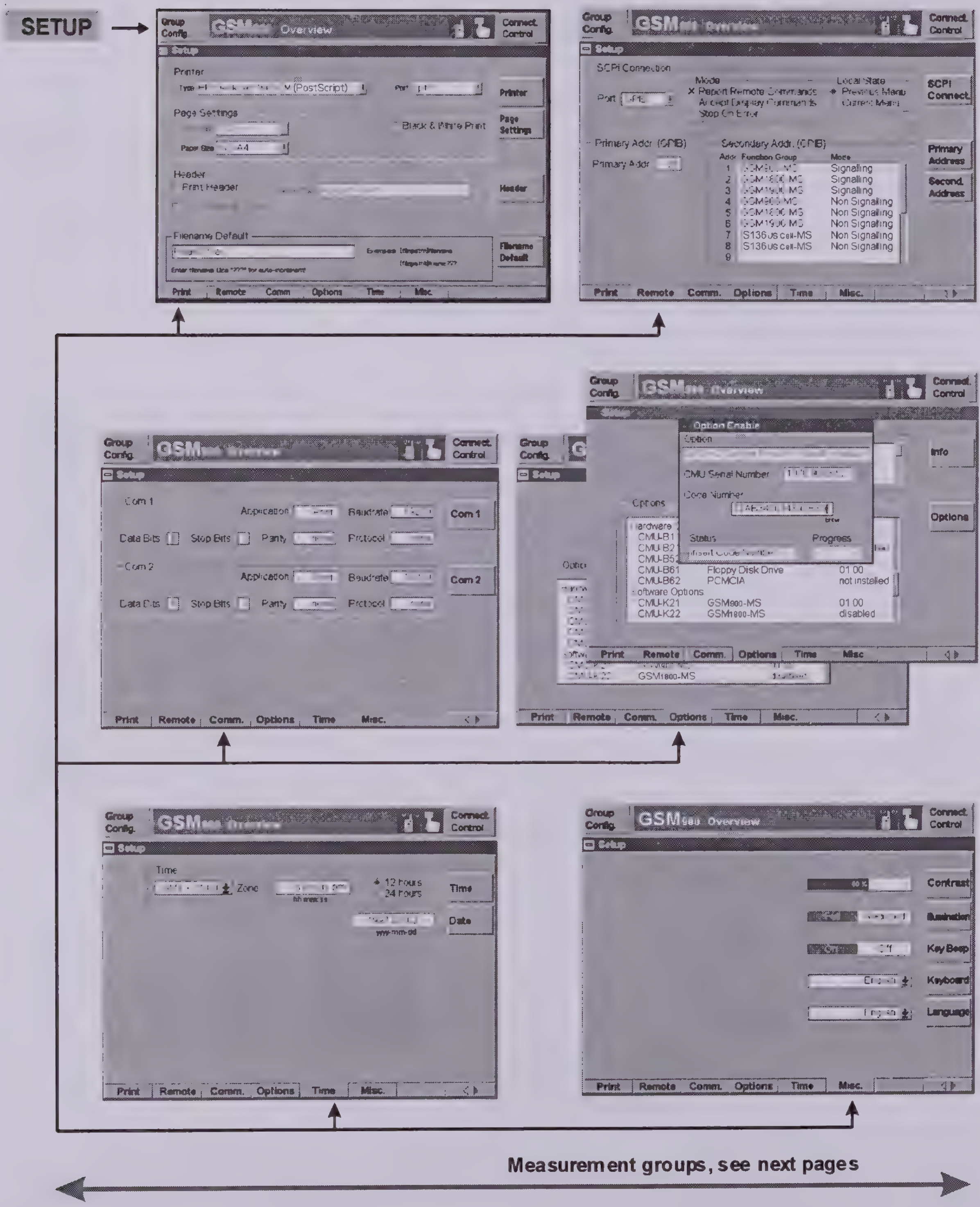
- Non-Signaling → Power
  - → Analyzer/Generator
  - → Power
  - → Modulation
  - → Spectrum
  - Audio →
    - → Analyzer / Generator
    - → Multitone
- Signaling → Power
  - → Overview
  - → Power
  - → Modulation
  - → Spectrum
  - → Receiver Quality

Hotkeys - Set 1
AUDIO Analyzer/Generator
GSM 400 Analyzer/Generator
GSM 400 Overview
GSM 850 Analyzer/Generator
GSM 850 Overview
GSM 900 Analyzer/Generator
Enter
Menu Select
Hotkeys Set 1
Hotkeys Set 2
Hotkeys Set 3
HotKey Assign

Measurement groups, see next pages

Fig. 3-5 CMU Base System – General Settings

CMU Base System – Setup


SETUP
Group Config.
GSM900 Overview
Connect. Control
Setup
Printer
Page Settings
Header
Filename Default
SCPI Connect.
Primary Address
Second. Address
Com 1
Com 2
Info
Options
Time
Date
Contrast
Illumination
Key Beep
Keyboard
Language
Print
Remote
Comm.
Options
Time
Misc.
Measurement groups, see next pages

SCPI Connection

Mode

× Report Remote Commands

Accept Display Commands

Stop On Error

Local State

● Previous Menu

Current Menu

Primary Addr. (GPIB)

Secondary Addr. (GPIB)

Addr	Function Group	Mode
1	GSM900-MS	Signalling
2	GSM1800-MS	Signalling
3	GSM1900-MS	Signalling
4	GSM900-MS	Non Signalling
5	GSM1800-MS	Non Signalling
6	GSM1900-MS	Non Signalling
7	IS136 US cell-MS	Non Signalling
8	IS136 US cell-MS	Non Signalling
9		

Option Enable

CMU Serial Number

Code Number

Status

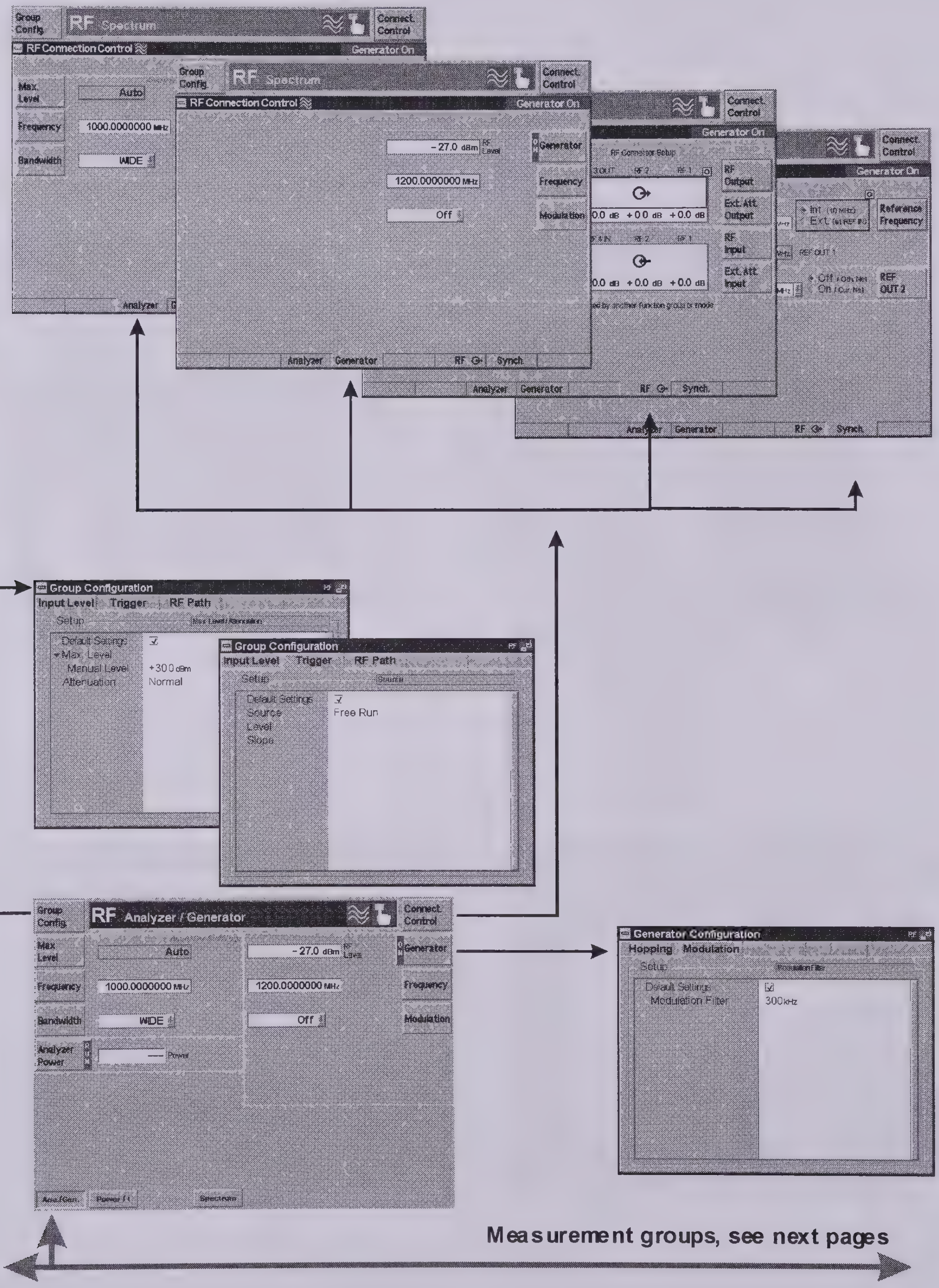
Progress

Options

Hardware		
CMU-B1		
CMU-B2		
CMU-B52		
CMU-B61	Floppy Disk Drive	01.00
CMU-B62	PCMCIA	not installed
Software Options		
CMU-K21	GSM900-MS	01.00
CMU-K22	GSM1800-MS	disabled

Fig. 3-6 CMU Base System – Setup

RF Measurements – General Configurations


Group Config.
RF Spectrum
Connect. Control
RF Connection Control
Generator On
Max. Level
Frequency
Bandwidth
Generator
Modulation
RF Connector Setup
RF Output
Ext. Att. Output
RF Input
Ext. Att. Input
Reference Frequency
REF OUT 2
Analyzer
Generator
RF
Synch.
Group Configuration
Input Level
Trigger
RF Path
Setup
RF Analyzer / Generator
Analyzer Power
Ana./Gen.
Power (t)
Spectrum
Generator Configuration
Hopping
Modulation

Max. Level: Auto

Frequency: 1000.0000000 MHz

Bandwidth: WIDE

RF Level: – 27.0 dBm

Frequency: 1200.0000000 MHz

Modulation: Off

+0.0 dB +0.0 dB +0.0 dB

+0.0 dB +0.0 dB +0.0 dB

Int (10 MHz) / Ext. (at REF IN)

REF OUT 2: Off / On

Setup: Max Level/Attenuation

Default Settings ☑

Max. Level

Manual Level +30.0 dBm

Attenuation Normal

Setup: Source

Default Settings ☑

Source Free Run

Level

Slope

Analyzer Power: ––– Power

Setup: Modulation Filter

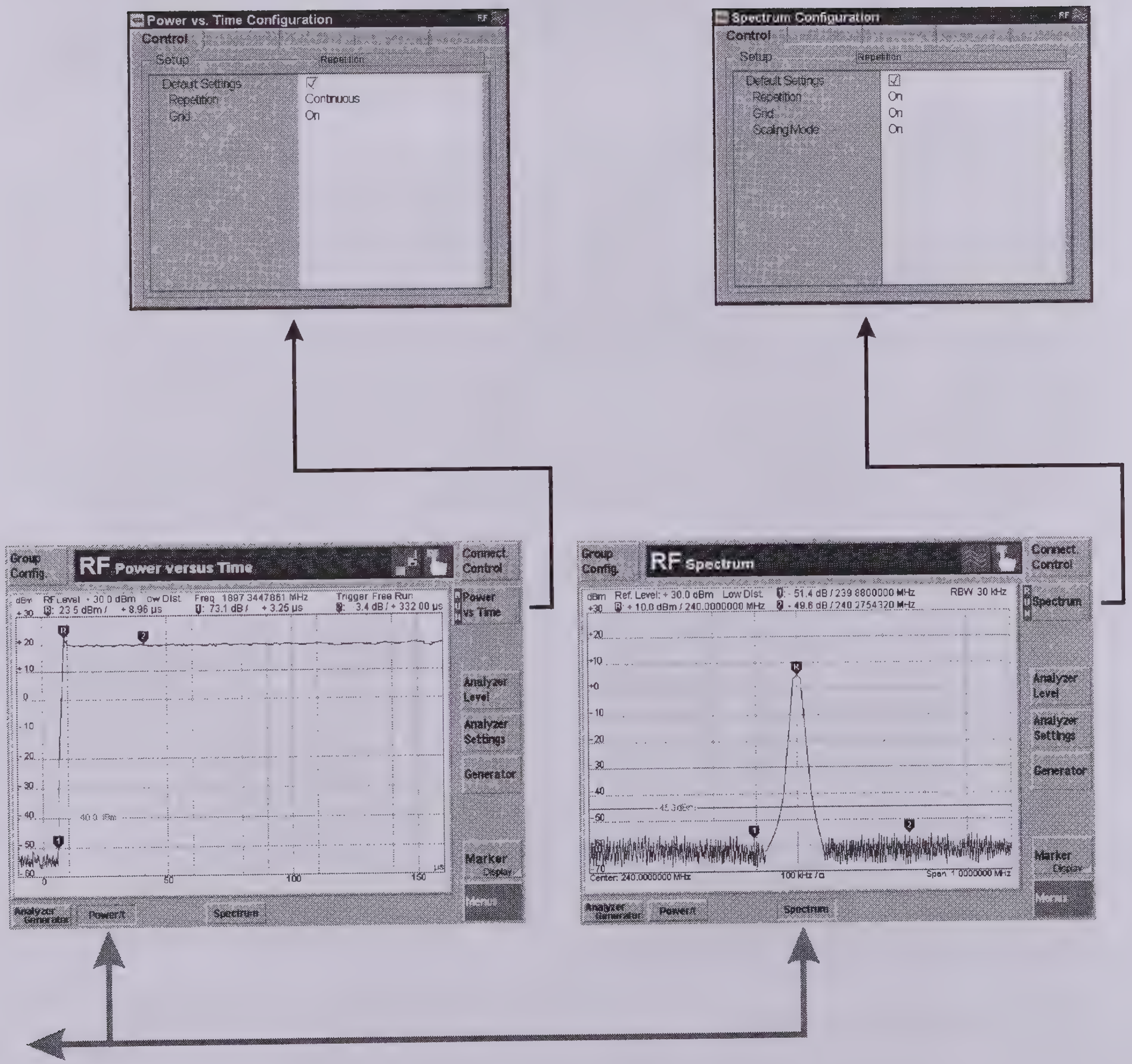
Default Settings ☑

Modulation Filter 300 kHz

Measurement groups, see next pages

Fig. 3-7 RF Measurements – General Configurations

RF Measurements – Power and Spectrum


Power vs. Time Configuration
RF
Control
Setup
Repetition
Spectrum Configuration
RF
Control
Setup
Repetition
Group Config.
RF Power versus Time
Connect. Control
Power vs Time
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menu
Analyzer Generator
Power/t
Spectrum
dBm
+30
+20
+10
0
-10
-20
-30
-40
-50
-60
0
50
100
150
µs
40.0 dBm
Group Config.
RF Spectrum
Connect. Control
Spectrum
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menu
Analyzer Generator
Power/t
Spectrum
dBm
+30
+20
+10
+0
-10
-20
-30
-40
-50
-60
-70
45.3 dBm

Power vs. Time Configuration:

Default Settings ☑
Repetition Continuous
Grid On

Spectrum Configuration:

Default Settings ☑
Repetition On
Grid On
Scaling Mode On

RF Power versus Time:

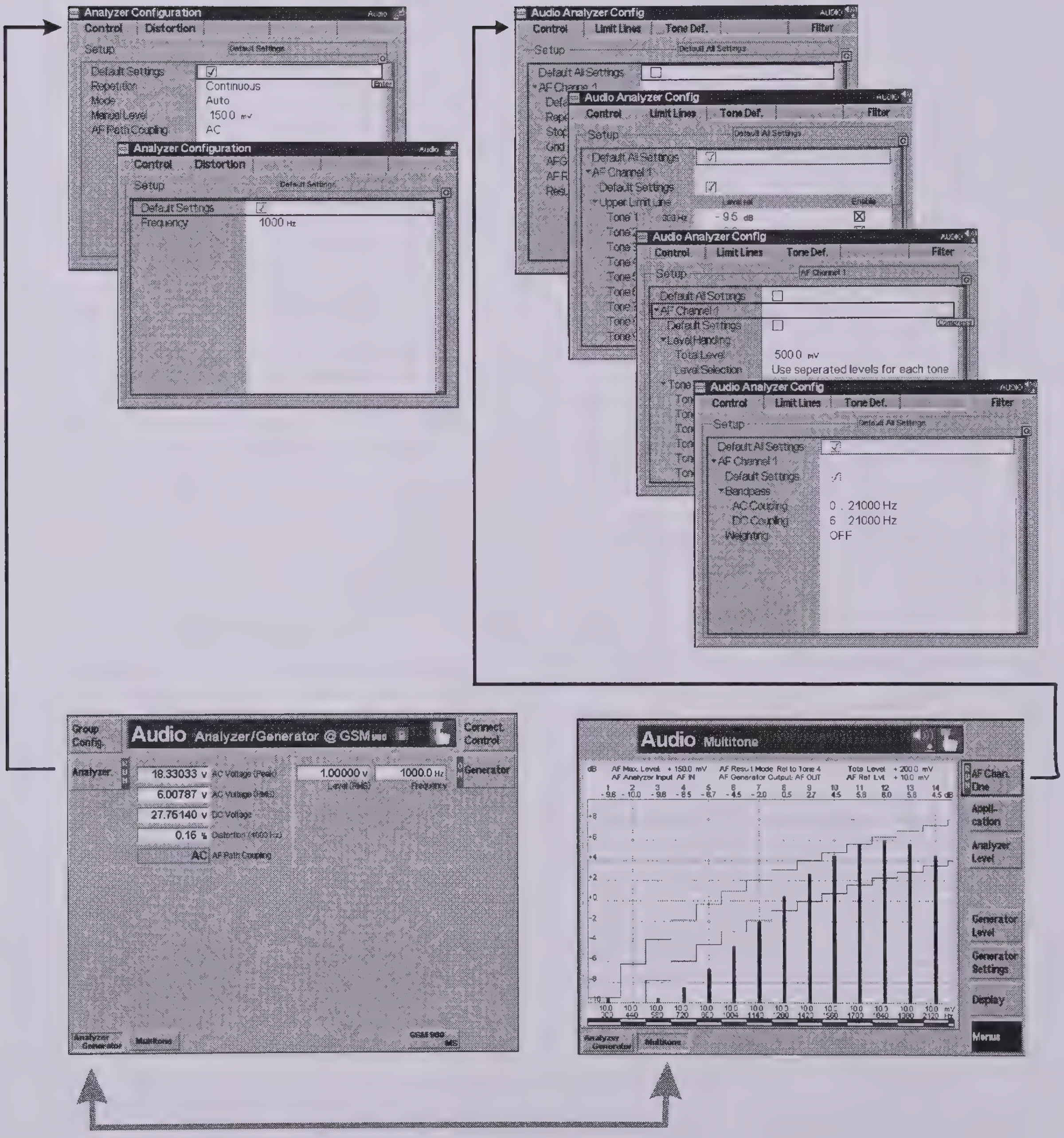
RF Level + 30.0 dBm Low Dist. Freq. 1897.3447861 MHz Trigger Free Run
R: 23.5 dBm / + 8.96 µs 1: 73.1 dB / + 3.25 µs 2: 3.4 dB / + 332.00 µs

RF Spectrum:

Ref. Level: + 30.0 dBm Low Dist. 1: - 51.4 dB / 239.8800000 MHz RBW 30 kHz
R: + 10.0 dBm / 240.0000000 MHz 2: - 49.6 dB / 240.2754320 MHz
Center: 240.0000000 MHz 100 kHz / D Span: 1.0000000 MHz

Fig. 3-8 RF Measurements – Power and Spectrum

Options: Audio Generator and Analyzer/Multitone


Analyzer Configuration
Audio
Control
Distortion
Setup
Default Settings
Enter
Audio Analyzer Config
AUDIO
Control
Limit Lines
Tone Def.
Filter
Default All Settings
AF Channel 1
Compress
Group Config.
Audio Analyzer/Generator @ GSM900
Connect. Control
Analyzer
Generator
Analyzer Generator
Multitone
GSM 900 MS
Audio Multitone
AF Chan. One
Appli-cation
Analyzer Level
Generator Level
Generator Settings
Display
Menus
dB
+8
+6
+4
+2
+0
-2
-4
-6
-8
-10
mV
Hz

Analyzer Configuration – Control:

Default Settings ☑
Repetition Continuous
Mode Auto
Manual Level 150.0 mV
AF Path Coupling AC

Analyzer Configuration – Distortion:

Default Settings ☑
Frequency 1000 Hz

Audio Analyzer Config – Control:

Default All Settings ☐

Audio Analyzer Config – Limit Lines:

Default All Settings ☑
AF Channel 1
Default Settings ☑
Upper Limit Line – Level rel – Enable
Tone 1 300 Hz -9.5 dB ☒

Audio Analyzer Config – Tone Def.:

Default All Settings ☐
AF Channel 1
Default Settings ☐
Level Handling
Total Level 500.0 mV
Level Selection Use seperated levels for each tone

Audio Analyzer Config – Filter:

Default All Settings ☑
AF Channel 1
Default Settings ☑
Bandpass
AC Coupling 0 . 21000 Hz
DC Coupling 6 21000 Hz
Weighting OFF

Audio Analyzer/Generator @ GSM900:

18.33033 V AC Voltage (Peak)
6.00787 V AC Voltage (RMS)
27.76140 V DC Voltage
0.16 % Distortion (1000 Hz)
AC AF Path Coupling
1.00000 V Level (RMS)
1000.0 Hz Frequency

Audio Multitone:

AF Max. Level + 150.0 mV
AF Analyzer Input AF IN
AF Result Mode Rel to Tone 4
AF Generator Output: AF OUT
Total Level + 200.0 mV
AF Ref Lvl + 10.0 mV

Tone	1	2	3	4	5	6	7	8	9	10	11	12	13	14
dB	-9.6	-10.0	-9.8	-8.5	-6.7	-4.5	-2.0	0.5	2.7	4.5	5.8	6.0	5.8	4.5
mV	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Hz	300	440	580	720	860	1004	1140	1280	1420	1560	1700	1840	1980	2120

Fig. 3-9 Audio Generator and Analyzer

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4 Functions and their Application

This chapter explains in detail all functions of the CMU and their application. The structure of the chapter is based on the menu groups and their function. It is organized like a typical measurement session including the following stages:

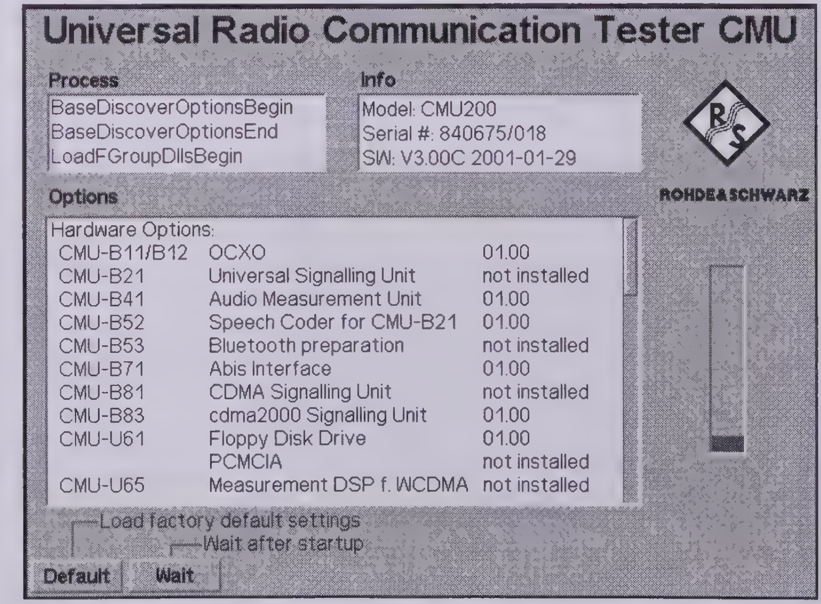
1. Startup menu
2. Menu selection
3. General device configurations
4. System information and hardware diagnosis
5. RF measurements (measurements and measurement results, configurations)
6. Audio Generator and Analyzer (Option CMU-B41) including Audio Multitone

In contrast to chapter 6, *Remote Control – Commands*, the measurement and results are explained first, special measurement configurations are relegated to the end of the chapter. The description of the softkeys is followed by the remote-control commands. Similarly, the description of the commands in chapter 6 also contains the corresponding menus of the user interface.

The description of the operating concept is to be found in chapter 3; besides, an overview of all menus is given at the end of chapter 3. To find information on a particular topic please refer to the index at the end of the manual.

Startup Menu

The startup menu provides information on the instrument and the installed options. It appears for a few seconds in the display after switching on the CMU and activating the operating mode (see section 1, *Switching on the Instrument/Startup Test*). During display of this menu, the CMU performs a startup test.



Universal Radio Communication Tester CMU

Process

BaseDiscoverOptionsBegin
BaseDiscoverOptionsEnd
LoadFGroupDllsBegin

Info

Model: CMU200
Serial #: 840675/018
SW: V3.00C 2001-01-29

Options

Hardware Options:

CMU-B11/B12	OCXO	01.00
CMU-B21	Universal Signalling Unit	not installed
CMU-B41	Audio Measurement Unit	01.00
CMU-B52	Speech Coder for CMU-B21	01.00
CMU-B53	Bluetooth preparation	not installed
CMU-B71	Abis Interface	01.00
CMU-B81	CDMA Signalling Unit	not installed
CMU-B83	cdma2000 Signalling Unit	01.00
CMU-U61	Floppy Disk Drive	01.00
	PCMCIA	not installed
CMU-U65	Measurement DSP f. WCDMA	not installed

Fig. 4-1 Startup menu

Displays in the startup menu

The display windows of the startup menu provide information on

- The startup procedure (*Process)*
- Instrument model, serial number and version of the CMU base software *(Info).*
- Installed hardware and software options and equipment *(Options)*. Available software options are listed with their version numbers.
- Progress of the startup procedure (*Startup* bar graph).

After terminating the startup procedure, the instrument changes to the last main menu or graphical measurement menu of the previous session.

Options

All the options of the CMU are listed in the section "Installation of Options (Setup – Options)" in this chapter.

Further information on the options is to be found in the data sheet. Installation and removal of options is described in chapter 4 of the service manual.

Hotkeys

During the startup procedure, the hotkeys of the startup menu are available.

Default

The *Default* hotkey activates the default settings of the instrument.

Wait

The *Wait* hotkey prevents the instrument from closing the *Startup* menu.

As a result of this, the *Wait* softkey changes to *Cont.* with the additional message *Change to last menu* displayed on top. Instead of changing to the last main menu or graphical measurement menu of the previous session the measurement can be continued by pressing a key *(Menu Select, Setup, ...).*

Reset of Instrument Settings (RESET Key)

The popup window *Reset* sets the selected instrument settings to their default values. It is opened via the *RESET* key (*CONTROL keypad*).

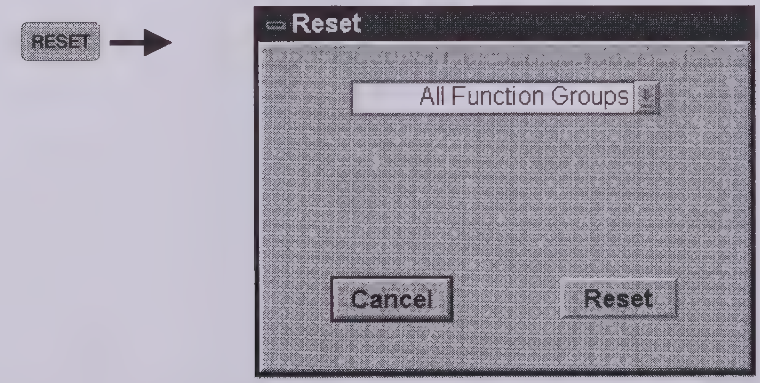


Fig. 4-2 Popup window Reset

Selection of the settings

The list field in the popup window Reset selects the settings or function groups to be reset. The following settings are available:

All Function Groups Reset all settings

Reset

The *Reset* button resets the selected settings.

A verify window pops up where the reset can be confirmed. While the reset is performed, the message *Reset in progress* is displayed. Then the popup window is closed.

Remote control
`SYSTem:PRESet`

Cancel

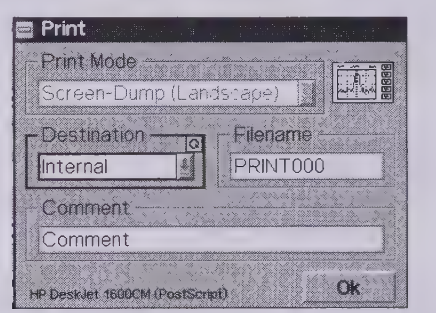
The *Cancel* button cancels the selection that has been made and closes the menu. *Cancel* is selected by default when the *Reset* menu is opened.

Remote control
–

Print Menu (PRINT Menu)

The popup window *Print* permits to print the current screen as configured in the *Print* tab of the *Setup* menu. It is called up on pressing the *PRINT* key (*SYSTEM* keypad).

PRINT →



Print Mode: Screen-Dump (Landscape)
Destination: Internal
Filename: PRINT000
Comment: Comment
HP DeskJet 1600CM (PostScript)

Fig. 4-3 Popup window Print

Print Mode

The *Print Mode* select field permits to specify the data type for the output:

Screen-Dump (Landscape)	Copy of the current display in landscape format

An example of a screen-dump copy is shown in a preview to the right of the select field.

Destination

The *Destination* select field permits to specify the output destination for the data:

Printer	Output to external printer connected via the parallel or one of the serial interfaces. The printer is configured in the *Setup –print* tab; see p. 4.6 ff.
Internal	Storing in the current printer format to directory c:\temp\<Dir> where <Dir> is the target directory specified in the *Filename Default* input field of the *Setup – Print* tab. If <Dir> is not explicitly defined, the files are written to c:\temp.
Internal WMF	Storing in *.wmf format.
External	Storing in the current printer format to the <Dir> target directory (see *Internal* above) on the PCMCIA card (right-hand slot, assigned to drive d:\) or floppy disk (with option CMU-U61). A message box *Please insert disc ! Repeat ? Yes/No* pops up if no storage medium is inserted in the drive. To print, insert the appropriate medium and confirm with *Yes*.
External WMF	Storing in *.wmf format to the PCMCIA card or floppy disk; see above.

Note: *To make processing of the generated data files easier, we recommend to use the External output destination.*

Filename

If the data is to be written to a file, a file name can be specified in the *Filename* input field. By default, files are stored with the file name defined in the *Setup –print* tab (see p. 4.6). Groups of 1 to 3 adjacent question marks in this default name are replaced by current numbers starting with zero (auto-increment function). If a file name used before is specified, or if a file where all question marks have been replaced by "9" is already stored in the target directory, a message box *Print: overwrite existing file Yes/No* pops up. Pressing *No* aborts the print procedure and closes the *Print* popup menu.

Comment

The input field *Comment* contains a comment (comprising up to 160 characters) for the current output. This field is not available if a *.wmf output is generated. When the output is sent to a printer the comment is written across the upper edge of the page.

Printer format

The current printer format is indicated below the *Comment* input field. To change this format, open the *Setup –print* tab (see p. 4.6) to select another printer.

Ok

The *Ok* button starts the data output and closes the *Print* menu.

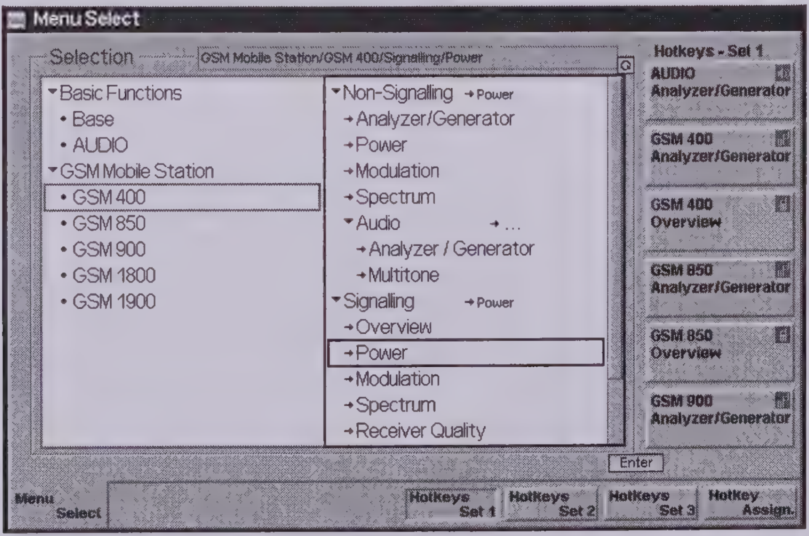
To cancel the print process while preserving the current settings and close the *Print* menu press the *PRINT* key again.

Remote control
–

Menu Select

The *Menu Select* menu gives an overview of all available measurements that can be selected and called up directly from the menu. The measurements are arranged in tables showing their hierarchical structure. *Menu Select* appears after termination of the startup procedure of the CMU or after pressing the *Menu Select* key. It is closed after selection on pressing the *ENTER* key or the *MENU SELECT* key again. The *ESCAPE* key discards the current selection.

MENU SELECT →


Selection: GSM Mobile Station/GSM 400/Signalling/Power

Menu Select
Basic Functions
• Base
• AUDIO
GSM Mobile Station
• GSM 400
• GSM 850
• GSM 900
• GSM 1800
• GSM 1900
Non-Signalling → Power
→ Analyzer/Generator
→ Power
→ Modulation
→ Spectrum
Audio → ...
→ Analyzer / Generator
→ Multitone
Signalling → Power
→ Overview
→ Power
→ Modulation
→ Spectrum
→ Receiver Quality
Hotkeys - Set 1
AUDIO Analyzer/Generator
GSM 400 Analyzer/Generator
GSM 400 Overview
GSM 850 Analyzer/Generator
GSM 850 Overview
GSM 900 Analyzer/Generator
Enter
Menu Select
Hotkeys Set 1
Hotkeys Set 2
Hotkeys Set 3
Hotkey Assign.

Fig. 4-4 Menu Select

Selection table: function groups

The left half of the *Selection* table contains all function groups available on the instrument. The CMU performs general RF measurements accessible via the function group:

RF	RF measurements, see below in this chapter

If equipped with option CMU-B41, it provides AF measurements via the function group:

Audio	Audio generator and analyzer including multitone measurements, see below in this chapter

It is a versatile measuring instrument for a large variety of digital and analog network tests (all of them are optional, see separate manuals). For a complete list of deliverable network tests please refer to the data sheet.

Selection table: test modes and menus

When a function group is selected, the measurements within this group are displayed in the right half of the table. A measurement generally consists of measurement menus and specific configuration menus. A complete graphical overview of all menus of the CMU basic system and the function groups *RF* and *Audio* can be found at the end of chapter 3 in this manual.

Most of the optional network test function groups are divided into the two independent test modes:

Non Signalling	Module tests; measurements without transmission of signalling parameters and call setup.
Signalling	Measurements with signalling and call setup to the device under test.

The test modes form the header lines of expandable table sections. A measurement may be available in both test modes of a function group, therefore, to uniquely define a measurement, it is necessary to specify its name, the test mode (if applicable) and the function group.

Example

In Fig. 4-4, the *Power* measurement is selected. This measurement belongs to the *Signalling* test mode in function group *GSM400-MS*. Another *Power* measurement belongs to the *Non Signalling* test mode of the same function group.

Hotkey Assign.

The *Hotkey Assign.* hotkey activates the assign mode used to assign a softkey to the function group, signalling mode and measurement menu currently selected.

The six softkeys of the *Menu Select* menu belonging to *Hotkeys Set 1* have a default assignment. In normal mode, each hotkey gives direct access to the menu assigned to it. Another two sets, each containing six softkeys, can be accessed by pressing the *Hotkeys Set 2* or *Hotkeys Set 3* hotkeys, respectively.

In the assign mode, the *Hotkey Assign.* softkey turns into *Exit Assign* softkey and *Hotkey Assignment* is displayed in the header of the *Menu Select* menu.

- ➢ To assign a softkey (or to change the current assignment), select the desired function group, mode and menu, and press *Hotkey Assign.* followed by the softkey. Press *Exit Assign.* to quit the assign mode.
- ➢ To cancel a hotkey assignment, press *Hotkey Assign.* followed by the *DEL* (delete) key and the softkey. Press *Exit Assign.* to quit the assign mode.

Note 1: *An empty configuration (all hotkeys de-assigned) will not be not stored after* Exit Assign. *Instead the CMU restores the default hotkey assignment of the current function group.*

Note 2: *A user-defined assignment is retained even after a Reset of all function groups* (Reset *key, see p. 4.2 f).*

Remote control
The CMU uses extended addressing: The instrument itself is identified by the primary GPIB address. Moreover, a secondary address must be assigned to any combination of a function group and a signalling mode. This is done with the command

```
SYSTem:REMote:ADDRess:SECondary <Address>,<FGrp>|NONE
```

Primary and secondary address handling is described in the remote control chapters (in particular, refer to chapter 5 and the program examples in chapter 7).

Hotkeys Set 1

The *Hotkeys Set 1* hotkey selects the softkey set 1 for display. The hotkey is active in normal mode and in assign mode; see description of previous hotkey.

The two hotkeys *Hotkeys Set 2* and *Hotkeys Set 3* are analogous to *Hotkeys Set 1.*

Audio Multitone

The labeling of each softkey on the right side of the menu contains the function group, an icon indicating the test mode, and the measurement assigned to the softkey. The function of the softkeys is as follows:

- In normal mode, pressing a softkey calls up the corresponding measurement.
- In assign mode, pressing a softkey assigns this softkey to the measurement selected in the *Selection* table. Pressing the *DEL* (delete) key and then the softkey cancels the current assignment.

Popup Menu Setup

The popup menu *Setup* contains several tabs used to adapt the CMU to user requirements. The menus are opened by pressing the *Setup* key. It is possible to change between the tabs by pressing the associated hotkeys.

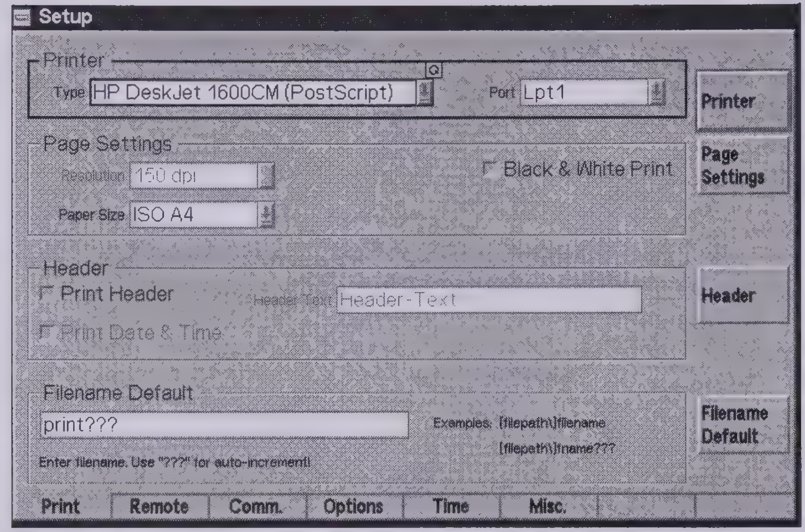
Printer Settings (Setup – Print)

The *Setup – Print* menu controls the output of data from the CMU to a printer or a storage medium. The following configurations are provided:

- Printer type and port selection *(Printer)*
- Page settings for the selected printer *(Page Settings)*
- A header for the printed page *(Header)*
- Default file name and directory *(Filename Default)*

Some of the *Setup – Print* configurations serve as default settings and can be modified in the *Print* popup menu before the print process is started (see p. 4.3).

SETUP →



Printer
Type HP DeskJet 1600CM (PostScript)
Port Lpt1

Page Settings
Resolution 150 dpi
Paper Size ISO A4
☐ Black & White Print

Header
☐ Print Header
Header Text Header-Text
☐ Print Date & Time

Filename Default
print???
Examples: [filepath\]filename
[filepath\]fname???
Enter filename. Use "???" for auto-increment!

Fig. 4-5 Printer configuration menu (Setup – Print)

Printer

The Printer softkey selects a printer type and the printer port. The connection of a printer is described in chapter 1.

Page Settings

The *Page Settings* softkey activates the input of the page settings for the selected printer.

Paper Size	Selection of ISO A4 or US LETTER paper
Black & White print	Color (check box off) or black & white printer

The printer resolution is 150 dpi.

Header

The Header defines and activates header for the printed page.

Print header	Print the header defined in the *Header Text* input field when a page is printed. An additional comment for every single page can be defined in the *Print* popup menu (see p. 4.3).
Print Date & Time	Inclusion of the current date and time in the header, provided that a header is to be printed.
Header Text	Input field for a header with a maximum length of two lines.

Filename Default

The Filename Default softkey defines a default file name and directory for an output that is written to an internal or external storage medium.

It is possible to specify a path separated from the filename by a backslash "\" in order to create a directory structure on the storage medium. This path is relative to directory c:\temp of the CMU hard disk *(Internal* storage) or the root directory of the *External* storage medium.

Auto-increment function

Groups of 1 to 3 adjacent question marks within the file name are replaced by current numbers that are automatically incremented, starting with zero. The file name *PRINT???* means that the first file stored will be *PRINT000*, the next one will be *PRINT001* etc. For n consecutive question marks, 10^n chronologically ordered and numbered files can be generated. In the last file name of the series, all question marks will be replaced by "9".

Remote control

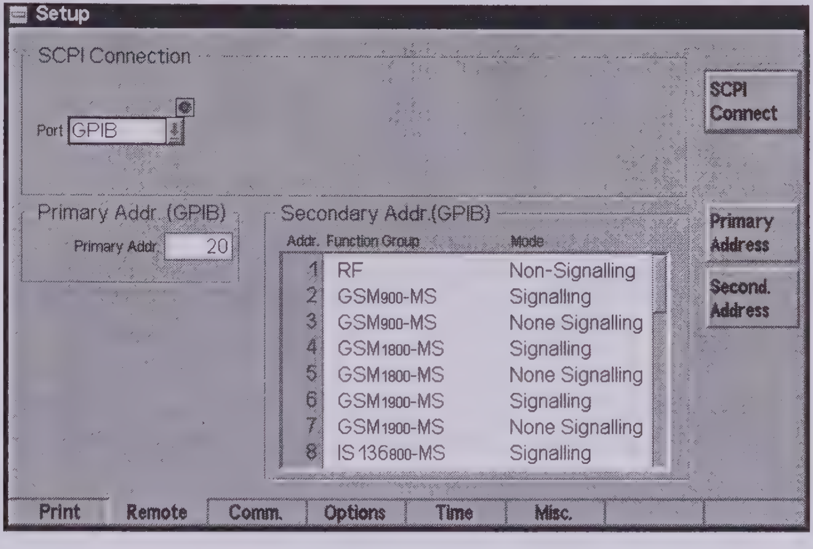
–

Remote-control Settings (Setup – Remote)

The remote-control menu *(Setup Remote)* defines the remote-control parameters of the CMU:

- Selection of the interface *(SCPI-Connection),*Setting of the IEC-bus address of the CMU *(Primary Address),*
- Selection of the desired function group *(Second. Address).*

SETUP →



Port: GPIB

Primary Addr. (GPIB)

Primary Addr. 20

Secondary Addr.(GPIB)

Addr.	Function Group	Mode
1	RF	Non-Signalling
2	GSM900-MS	Signalling
3	GSM900-MS	None Signalling
4	GSM1800-MS	Signalling
5	GSM1800-MS	None Signalling
6	GSM1900-MS	Signalling
7	GSM1900-MS	None Signalling
8	IS 136800-MS	Signalling

Fig. 4-6 IEC-bus menu

SCPI Connect

The SCPI Connect softkey determines the remote-control interface of the CMU.

The following interfaces are available:

• *GPIB*	IEEE-bus interface according to IEEE 488,
• *COM 1*	serial (RS-232-C) interface COM 1,
• *COM 2*	serial (RS-232-C) interface COM 2.

For the characteristics of the interfaces see chapter 1 and chapter 8, "Hardware Interfaces ".

Primary Address

The Primary Address softkey sets the IEC-bus address of the CMU. The default setting is 20; addresses 0 to 30 are permissible.

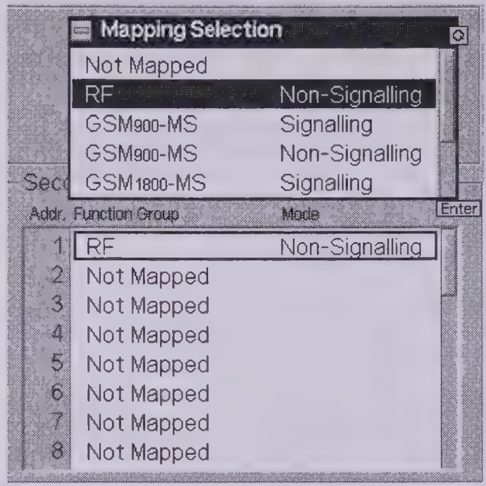
The IEEE-bus address is addressed in the remote-control commands in the form of the associated primary address, see chapter 5, Putting the CMU into Operation for , and chapter 7, *Program Examples.*

Remote control

```
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess  0 to 30
SYSTem:REMote:ADDRess:PRIMary  0 to 30
```

Second. Address

The Second. Address softkey activates a field for selecting the desired function group and the signalling state.


Mapping Selection
Not Mapped
RF Non-Signalling
GSM900-MS Signalling
GSM900-MS Non-Signalling
GSM1800-MS Signalling
Enter
Sec

Addr.	Function Group	Mode
1	RF	Non-Signalling
2	Not Mapped	
3	Not Mapped	
4	Not Mapped	
5	Not Mapped	
6	Not Mapped	
7	Not Mapped	
8	Not Mapped	

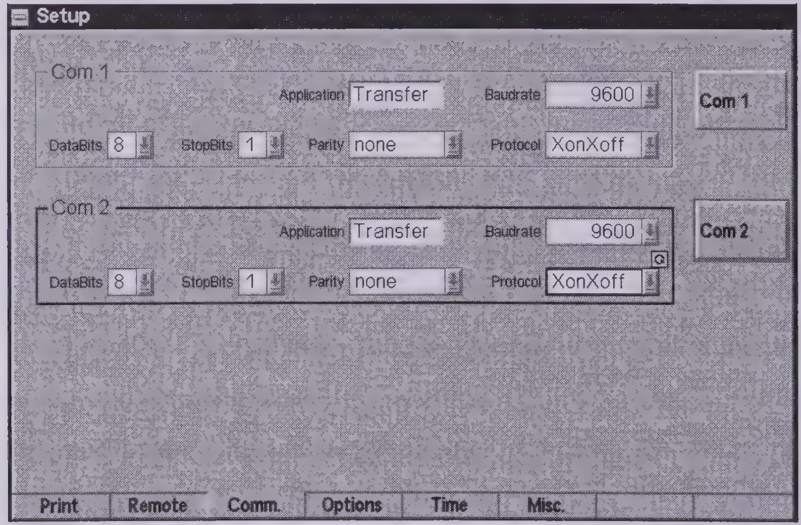
The network and the test (signalling) mode are addressed in the remote-control commands in the form of the associated *secondary address*, see chapter 5, *Putting the CMU into Operation for* , and chapter 7, *Program Examples*.

Remote control
`SYSTem:REMote:ADDRess:SECondary  1 to 30,<FgrpName> | NONE`

Setting the Serial Interfaces (Setup – Comm.)

The interface menu *(Setup Comm.)* defines the transmission parameters of the serial outputs COM 1 and COM 2.

SETUP →


Setup
Com 1
Com 2
Print
Remote
Comm.
Options
Time
Misc.

Com 1
Application Transfer
Baudrate 9600
DataBits 8
StopBits 1
Parity none
Protocol XonXoff

Com 2
Application Transfer
Baudrate 9600
DataBits 8
StopBits 1
Parity none
Protocol XonXoff

Fig. 4-7 Interface menu

COM 1

The COM 1 softkey defines the transmission parameters for the serial interface COM 1.

If required, the transmission parameters must be set such as to comply with the parameters of the addressed device (PC etc.). The interface characteristics are explained in detail in chapter 8, *Hardware Interfaces*. The individual parameters are presented in Table 4-1 below.
The *Application* field indicates whether the serial port is used as a printer connector *(Printer,* if COM 1 was selected as printer port in the *Print* tab; see p. 4.6) or for data transfer to the controller (Transfer, default setting). This parameter can not be changed in the *Comm.* tab.

Remote control
```
SYSTem:COMMunicate:SERial1:APPLication
SYSTem:COMMunicate:SERial1:TRANsmit:PACE... etc.
```

Table 4-1 Transmission parameters of the serial interfaces

Parameter	**Meaning**	**Value range**
Application	Addressed device	Transfer | Printer (fixed setting)
Baud Rate	Data transmission rate	110 |300 | 600 | 1200 | 2400 | 4800 | 9600 | 19200
Data Bits	Number of data bits	7 | 8
Stop Bits	Number of stop bits	1 | 2
Parity	Number of parity bits	none | odd | even
Protocol	Transmission protocol	none | XonXoff | CtsRts

COM 2

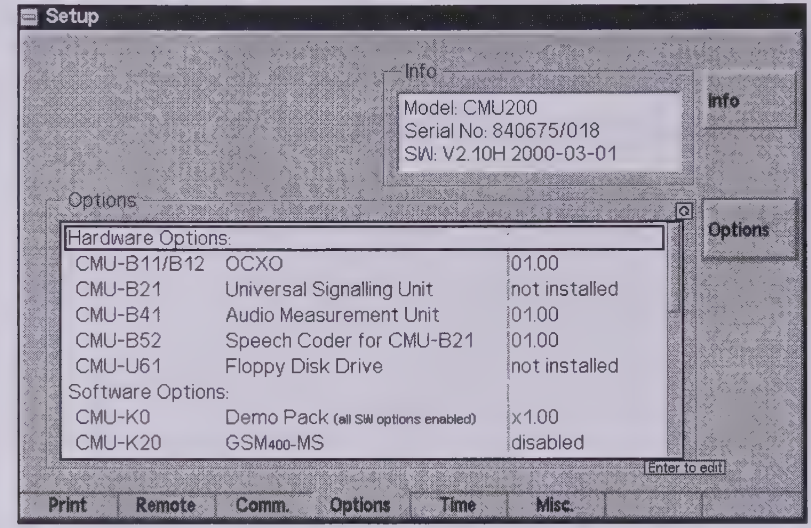
The COM 2 softkey defines the transmission parameters for the serial interface COM 2. The parameters are analogous to the COM 1 parameters.

Remote control
```
SYSTem:COMMunicate:SERial2:APPLication
SYSTem:COMMunicate:SERial2:TRANsmit:PACE... etc.
```

Installation of Options (Setup – Options)

The option menu *(Setup Options)* provides information on the type of instrument *(Info)* and the installed options *(Options)*. New software options purchased can be enabled in this menu using a code number.

SETUP →



Info

Model: CMU200
Serial No: 840675/018
SW: V2.10H 2000-03-01

Options

Hardware Options:		
CMU-B11/B12	OCXO	01.00
CMU-B21	Universal Signalling Unit	not installed
CMU-B41	Audio Measurement Unit	01.00
CMU-B52	Speech Coder for CMU-B21	01.00
CMU-U61	Floppy Disk Drive	not installed
Software Options:		
CMU-K0	Demo Pack (all SW options enabled)	x1.00
CMU-K20	GSM400-MS	disabled

Fig. 4-8 Option menu

Info

The Info softkey opens a field where information on the instrument is listed.

The information field contains the following specifications:

Model	instrument model,
Serial No.	serial number of the instrument,
Base SW	installed firmware with date of release.

Remote control
`SYSTem:OPTions:INFO?`

Options

The Options softkey activates a list of all hardware and software options and accessories for the CMU.

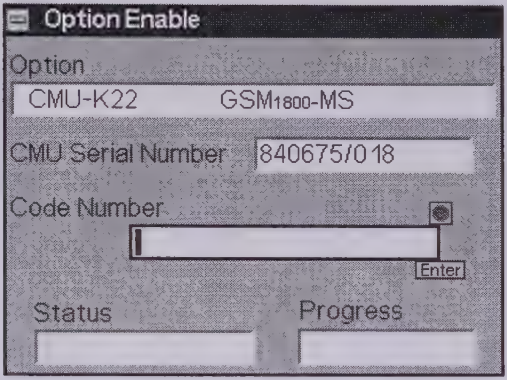
Software options purchased with the instrument are already enabled; additional software options can be enabled by simply entering a key code (see below). Further information on the options can be found in the data sheet. Installation and removal of hardware options is described in chapter 4 of the CMU service manual.

Remote control
`SYSTem:OPTions?`

Enabling options Additional software options purchased can be enabled in the list field of the *Options* softkey. As all software options are already included in the firmware, enabling does not require any re-installation, but only a key code which is supplied with the option.

- ➢ Select the respective line in the options list (in the example of Fig. 4-8 the line "CMU-K22 GSM1800-MS disabled"),
- ➢ Press the *Enter* key.

The input window *Option Enable* appears on the screen:



CMU-K22 GSM1800-MS

CMU Serial Number 840675/018

The *Option Enable* window contains the following fields:

Option	Short designation and name of option,
CMU Serial Number	Serial number of the CMU basic instrument,
Code Number	Code number of the option to be installed,
Status	Indication of the next operating step to perform,
Progress	Progress of the enabling procedure.

Of the five fields, only the *Code Number* can be edited. The name of the option being enabled and the serial number of the CMU are automatically entered into the corresponding fields.

- Enter the code number of the option in the input field *Code Number*.
- Confirm the entry using *Enter*.

The option is automatically enabled.

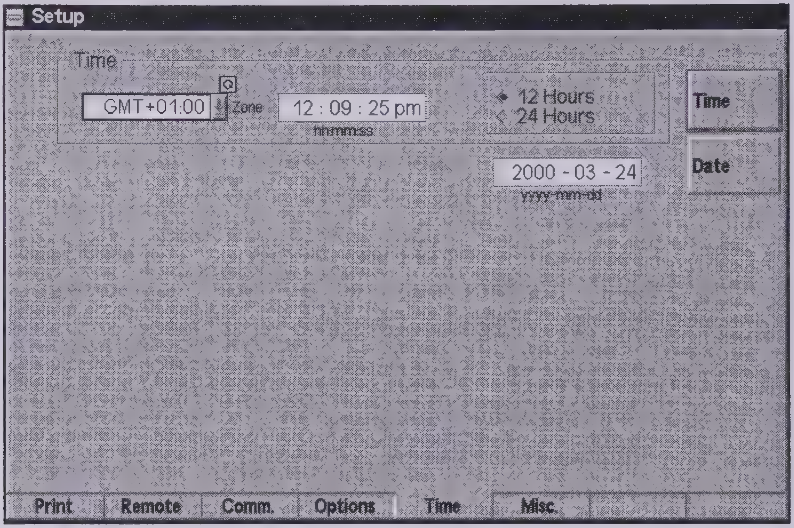
Remote control
–

Time Settings (Setup – Time)

The *Setup Time* tab shows and permits to change the following settings:

- The (current) time zone, time and time convention *(Time)*
- The (current) date *(Date)*

SETUP →



Time

Zone: GMT+01:00

hh:mm:ss: 12 : 09 : 25 pm

● 12 Hours
○ 24 Hours

yyyy-mm-dd: 2000 - 03 - 24

Fig. 4-9 Time menu

Time

The Time softkey defines the current time and its display format.

It activates the following input fields:

Zone	Selection of the time zone, Middle European time (Greenwich mean time (GMT) + 1 h) is set by default,
hh:mm:ss.	Time in the format hours:minutes:seconds,
12 hours	English time convention: 12:00:00 am ... 11:59:59 am, 12:00:00 pm ... 11:59:59 pm,
24 hours	European time convention: 0:00:00 ... 23:59:59.

Remote control

```
SYSTem:TIME:TIME
SYSTem:TIME:TZONe
```

Date

The Date softkey defines the current date in the format yyyy-mm-dd (year-month-day).

Remote control

```
SYSTem:DATe
```

Acoustic Signal and Keyboard (Setup – Misc.)

The *Setup Misc.* menu activates the acoustic signal *(key beep)* and selects the keyboard assignment *(Keyboard).*

SETUP →

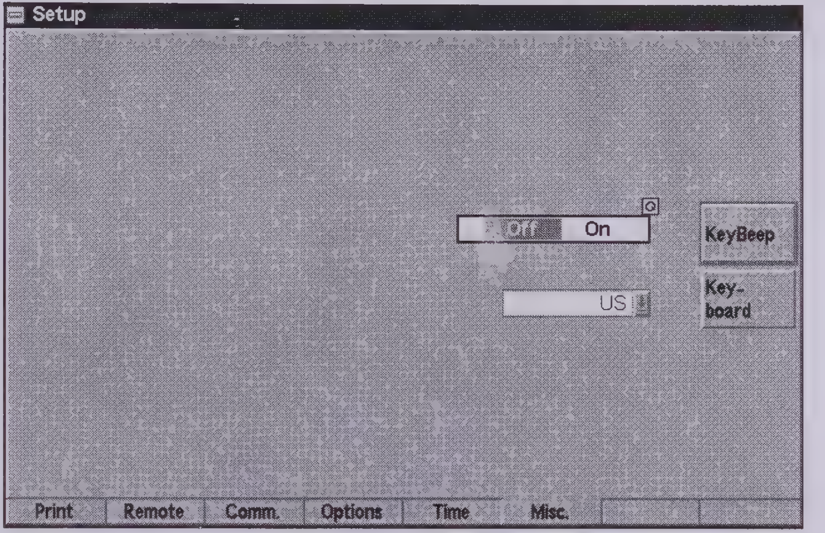

Setup
Off
On
KeyBeep
US
Key-
board
Print
Remote
Comm.
Options
Time
Misc.

Fig. 4-10 Setup – Misc. menu

Key Beep

The Key Beep softkey switches the acoustic signal of the CMU on or off.

If the key beep is on the CMU sends a discreet acoustic signal whenever a key is pressed. The default setting is *Off.*

Remote control
`SYSTem:MISCellaneous:KBEep`

Key-board

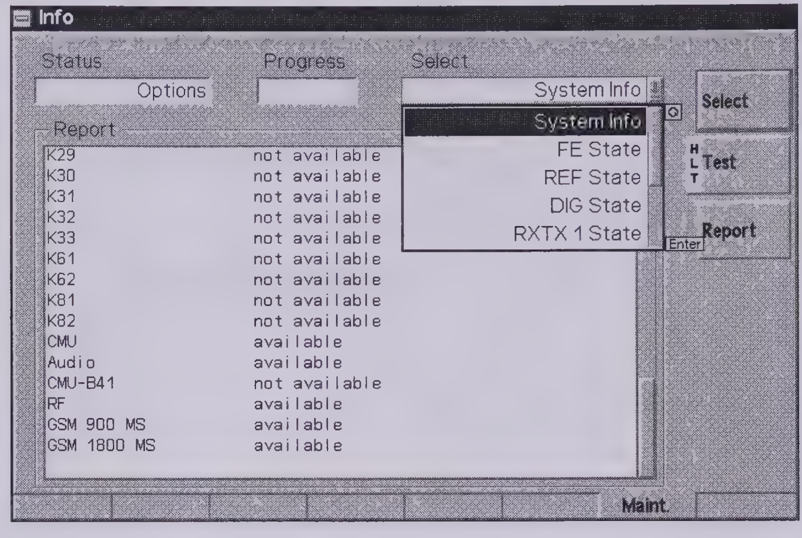
The Keyboard softkey selects the keyboard assignment (German or US keyboard).

Remote control
`SYSTem:MISCellaneous:KEYBoard`

System Information (Info)

In the *Info* popup menu, which is opened by pressing the *INFO* key, comprehensive information on the instrument and its components can be displayed.

INFO →



Status: Options

Progress

Select: System Info

Report

```
K29           not available
K30           not available
K31           not available
K32           not available
K33           not available
K61           not available
K62           not available
K81           not available
K82           not available
CMU           available
Audio         available
CMU-B41       not available
RF            available
GSM 900 MS    available
GSM 1800 MS   available
```

Fig. 4-11 System Information – Info menu

Select

The Select softkey selects the type of information to be displayed.

The following options are provided:

System Info	Provides information on the system configuration. If *System Info* is selected and the *Test* activated (see below), the CMU lists all deliverable hardware and software options in the report table and indicates whether they are available on your CMU.

The remaining options are to retrieve diagnosis voltages and configuration info about different hardware modules, primarily for service purposes. The information is obtained as explained for *System Info*.

Remote control
–

Test

The *Test* softkey collects the information selected via the *Select* softkey and displays it in the Report table.

The status of the selftest *(RUN, OFF, HLT;* the *RUN* state usually last only for a very short time) is indicated – like any other measurement status – on the left side of the softkey. It can be changed after softkey selection (press once) by means of the *ON/OFF* key.

A short description of the current test appears in the *Status* output field; its progress is shown in the *Progress* bar.

Remote control
–

Report

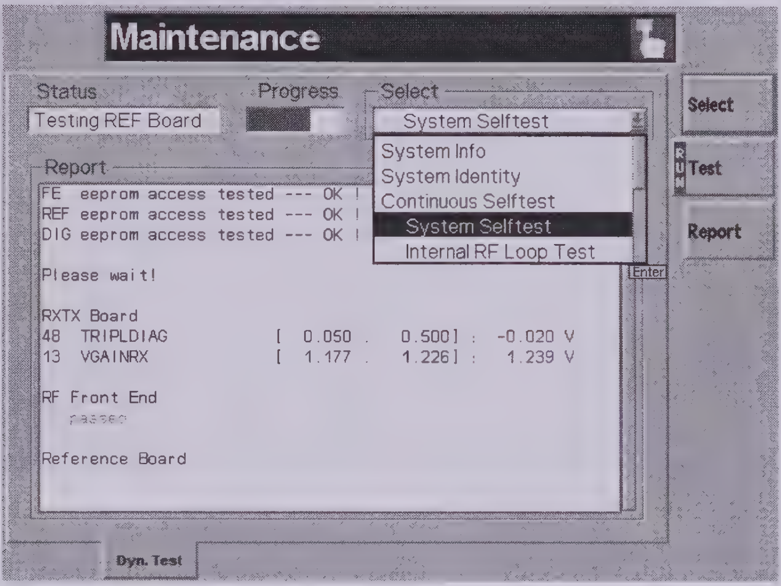
The *Report* softkey activates the *Report* table, e.g. for scrolling.

Remote control
–

Selftest (Maintenance)

The *Maintenance* popup menu, which is accessible via the *BASE* function group in the *Menu Select* menu, complements the *Info* menu (see p. 4.15 above) in providing service information and selftests. The selftests are primarily intended for production and service purposes and therefore not needed during normal operation of the instrument. The following description serves as a general overview.

Menu Select



Status: Testing REF Board

```
FE  eeprom access tested --- OK !
REF eeprom access tested --- OK !
DIG eeprom access tested --- OK !

Please wait!

RXTX Board
48  TRIPLDIAG          [  0.050 .   0.500] :  -0.020 V
13  VGAINRX            [  1.177 .   1.226] :   1.239 V

RF Front End
   passed

Reference Board
```

Fig. 4-12 Selftest – Maintenance menu

Select

The *Select* softkey selects the type of selftest to be performed.

The following options are provided:

System Info	Provides information on the system memory and the hardware and software configuration. If *System Info* is selected and the *Test* activated (see below), the CMU lists all deliverable hardware and software options in the report table and indicates whether they are available on your CMU.
System Identity	Scans all modules and stores the part numbers and production data to file c:\identity.dat.
Continuous Selftest	Continuous combined *System Selftest* and *Internal RF Loop* selftest.
System Selftest	Test all modules one after another and displays a pass/fail message.
Internal RF Loop Test	Test of frequencies and levels at connectors RF1 and RF2 using the CMU's internal RF generator and analyzer with internal RF coupling.
1->4/3->2 RF Loop T.	Test of frequencies and levels for the RF path between the connectors RF1 –> RF4 IN and RF3 OUT –> RF2. For this test, special external N coax cables (included in service kit CMU-Z3) must be used.

The remaining options provide selftests for individual modules (e.g. Frontend, Reference Board, Digital Board, RXTX Board 1, Audio Board).

Remote control

–

Test

The *Test* softkey controls the selftest of the type selected via the *Select* softkey and displays the results in the *Report* table.

The status of the selftest *(RUN, OFF, HLT)* is indicated on the left side of the softkey. It can be changed after softkey selection (press once) by means of the *ON/OFF* key.

A short description of the current test appears in the *Status* output field; its progress is shown in the *Progress* bar.

Remote control
–

Report

The *Report* softkey activates the *Report* table, e.g. for scrolling.

Remote control
–

RF Measurements (RF)

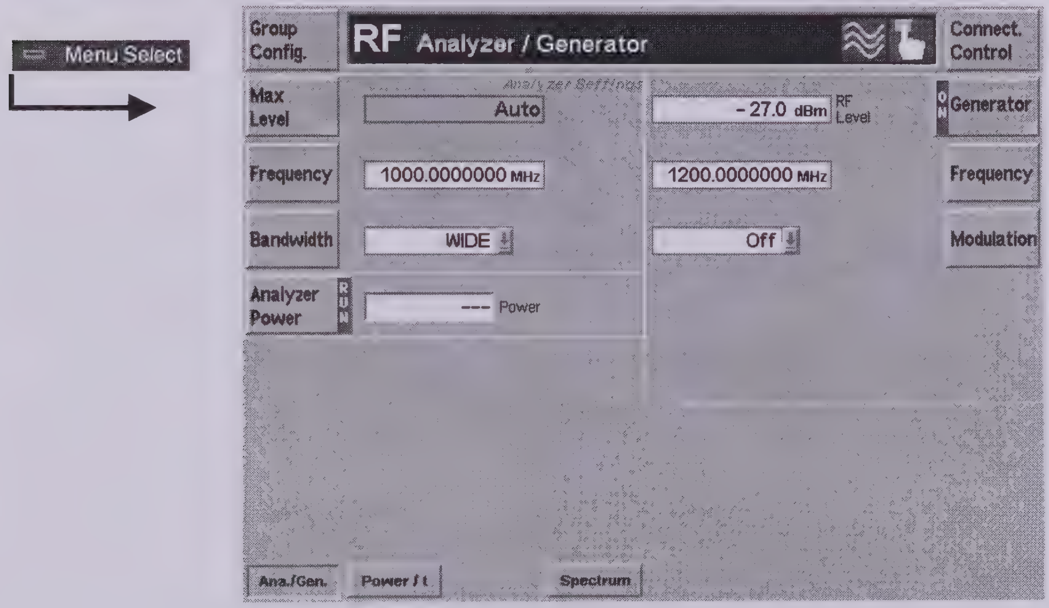
This section describes the measurement and configuration menus of function group *RF*. It is organized as follows:

1. Configuration of the RF output signal and RF analyzer settings *(Analyzer/Generator).*
2. Measurement menus *(Power versus Time* and *Spectrum):* Measurement menus, results, configuration menus.
3. General (global) configurations *(Group Configuration, Connection Control).*

Measurement Menu Analyzer/Generator

The main menu *Analyzer/Generator* configures the RF generator and analyzer and displays the power of the received RF signal.

The main menu *Analyzer/Generator* is opened from the main menu *Menu Select* (with associated key at front of instrument). It can also be accessed from the other measurement menus of the function group *RF* via the *Ana./Gen.* hotkey.

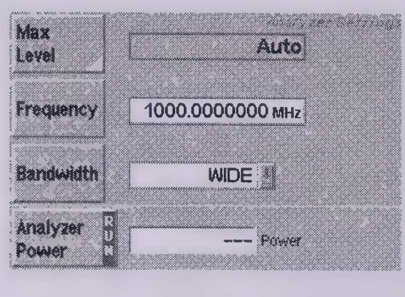

Menu Select
Group Config.
RF Analyzer / Generator
Connect. Control
Analyzer Settings
Generator
Frequency
Modulation
RUN
ON
Ana./Gen.
Power / t
Spectrum

Max Level: Auto
Frequency: 1000.0000000 MHz
Bandwidth: WIDE
Analyzer Power: --- Power
RF Level: - 27.0 dBm
1200.0000000 MHz
Off

Fig. 4-13 Measurement menu Analyzer / Generator

Analyzer Settings

The *Analyzer* panels configure the RF analyzer, control the measurement of the signal power and indicate the result. The signal power can be analyzed in detail in time-domain (oscillographical) and frequency-domain (spectral) representation in the measurement menus *Power versus Time* (p. 4.24) and *Spectrum* (p. 4.32).



Max Level: Auto
Frequency: 1000.0000000 MHz
Bandwidth: WIDE
Analyzer Power: --- Power

The panel *Analyzer* contains three input fields for the maximum level, the input frequency and the resolution bandwidth of the analyzer. Below, the analyzer can be started and stopped and the power of the measured signal is indicated.

Max. Level

The Max. Level softkey sets the maximum expected input level, i.e. it limits the input level which can be measured by the CMU.

This parameter is identical with the maximum input level in the popup menu *Group Configuration* (see page 4.45) and also determines the upper edge of the diagram in the *Power versus Time* menu (see page 4.29 ff). The range of values depends on the RF input used. If an external input attenuation is reported to the instrument (see section *Control of Input and Output Signals (Connection Control – Generator)* on page 4.40), all levels measured are referenced to the output of the DUT and therefore shifted with respect to the actual level at the input connectors of the CMU. The level ranges for the input connectors are shifted as well.

In general, input levels exceeding the *Max. Level* can not be measured; the corresponding measurement result fields indicate "– – –". The only exception is measurement with a wide-band filter (see *Bandwidth* softkey below, setting *WIDE)* where the analyzer level range is not restricted by *Max. Level.*

The input field is activated when the softkey is pressed once (softkey selection, *Max. Level* can be edited). Pressing the selected softkey once again calls up the popup menu *Group Configuration* (see page 4.45) with the tab *Input Level.* The *Group Configuration* menu can be closed on pressing *Max. Level* for a third time.

In the *Group Configuration* menu, either manual or automatic setting of the input level can be selected. The behavior of the *Max Level* softkey depends on the way the input level is set:

- In manual mode, the input level is indicated in the input field to the right of the softkey. This field can be activated and the level changed by pressing the softkey once. If the softkey is pressed again, the Group Configuration menu is called up (see page 4.45).
- If autoranging is selected, *Auto* is indicated in the input field to the right of the softkey. This field can not be activated. Instead, if the softkey is pressed once, the *Group Configuration* menu is called up (see page 4.45) to change the input level and mode.

The *Max. Level* setting has no impact if the bandwidth is set to *WIDE.*

Remote control
`[SENSe:]LEVel:MAXimum <LEVel>`

Frequency

The Frequency softkey defines the center frequency of the analyzer. This setting is identical with the frequency setting in the graphical measurement menus *Power versus Time* (p. 4.24).

Remote control
`[SENSe:]POWer:FREQuency:CENTer <Frequency>`

Bandwidth

The Bandwidth softkey defines the resolution bandwidth of the analyzer.

The nominal resolution bandwidth is the 3-dB bandwidth of the selection filter. From a list discrete bandwidths between 10 Hz and 1 MHz can be selected. The frequencies in the list are given by $1x10^n$ Hz, $2x10^n$ Hz, $3x10^n$ Hz, $5x10^n$ Hz where n=1 to 5. In addition the two values 1 MHz and WIDE (denoting measurement at the front end with no restriction of the analyzer frequency and level) can be selected.

The wide-band measurement is only accurate if the correct center frequency is set.

Resolution bandwidths for the *Power versus Time* and *Spectrum* measurements can be set independently (pp. 4.24, 4.32).

Remote control

```
[SENSe:]RFANalyzer:BANDwidth[:RESolution] <Bandwidth>
```

Analyzer Power

The Analyzer Power softkey indicates the status of the measurement (RUN | HLT | OFF). This status can be changed by means of the *ON/OFF* and *CONT/HALT* keys after softkey selection (pressing once). The current result (mode *RUN)* or the latest result (modes *Off*, *HLT*) is indicated in the output field next to the softkey.

Remote control

```
INITiate:RFANalyzer
ABORt:RFANalyzer
STOP:RFANalyzer
CONTinue:RFANalyzer
FETCh:RFANalyzer:STATus?
FETCh[:SCALar]:RFANalyzer:POWer[:RESult]? etc.
```

Generator Settings

The layout and function of the panel for configuration of the generator signals is identical with the *Signal* tab in the *Connection Control* popup menu (see page 4.40).

Generator

The softkey Generator controls the RF generator and indicates its operating status (ON | HLT | OFF).

The RF generator can be switched on or of after softkey selection (press once) using the ON/OFF key. Pressing the Generator softkey twice opens the popup menu Generator Configuration (see page 4.22) providing further configuration settings.

The level is entered in the associated input field RF Level as an absolute value (in dBm). The value range depends on the selected RF output (RF 1, RF 2 or RF 3 OUT).

External attenuation

If an external gain or attenuation is used and reported to the instrument (see softkey Ext. Att. Output in the menu Connector/Ext. Att. on page 4.41) the RF generator level is adjusted to maintain the commanded power after the attenuation or gain. As a consequence, all levels indicated are referenced to the input of the DUT and no longer correspond to the actual level at the output connectors of the CMU (see section *Control of Input and Output Signals (Connection Control – Generator)* on page 4.40). The default value for the generator power is also shifted provided that the generator can output the required power, compensating for the external attenuation or gain. Otherwise it is adapted to the level closest to the shifted default value.

Error messages

If the value determined for RF Level is too high or too low, a window with the error message "<Max_Level> is out of range. <permissible max. value> is limit." and three fields will appear:

Accept	The permissible max. value is accepted as RF Level,
Re-edit	RF Level is entered once again,
Cancel	The last valid input value is maintained.

When switching over to another output, the current value of RF Level is automatically adapted, if required:

- Towards lower values to the maximum permissible value of the new output,
- Towards upper values to the minimum value of the new output.

Remote control

```
INITiate:RFGenerator
ABORt:RFGenerator
FETCh:RFGenerator:STATus?
FETCh[:SCALar]:RFGenerator:POWer[:RESult]? etc.
SOURce:RFGenerator:LEVel <Level>
```

Frequency

The Frequency softkey defines the frequency of the generated RF signal.

Remote control

```
SOURce:RFGenerator:FREQuency <Frequency>
```

Modulation

The Modulation softkey selects the modulation mode of the RF signal.

OFF	Unmodulated (CW) RF carrier signal
SSB	RF carrier is shifted by a constant AF offset frequency defined with the AF Frequency softkey (Single Side Band modulation).
AM	RF carrier is amplitude-modulated by means of AF signal with constant frequency and modulation index set with the AF Frequency and Modulation Index softkeys.

Note: *The AM setting shifts the level ranges of all three RF outputs by –6 dB.*

Remote control

```
SOURce:RFGenerator:MODulation OFF | SSB | AM
```

AF Frequency

The AF Frequency softkey defines an AF frequency which is used for SSB or AM modulation; see Modulation softkey above.

If SSB modulation is set, the frequency of the RF carrier signal is shifted by the AF frequency, which can be either positive or negative. If AM modulation is set, the RF signal is amplitude-modulated with the AF frequency (which has to be positive) and with a given modulation index (see softkey Modulation Index below). An application for SSB modulation is given in chapter 7.

Remote control

```
SOURce:RFGenerator:MODulation:SSB:FREQuency <Frequency>
```

Modulation Index

The Modulation Index softkey defines the modulation index for AM modulation, i.e. the amplitude ratio of the modulating AM signal to the RF carrier signal in percent.

The modulation index is in the range of 0% (no amplitude modulation) to 100%. Overmodulation is excluded.

Remote control

```
SOURce:RFGenerator:MODulation:AM:INDex <Mod_Index>
```

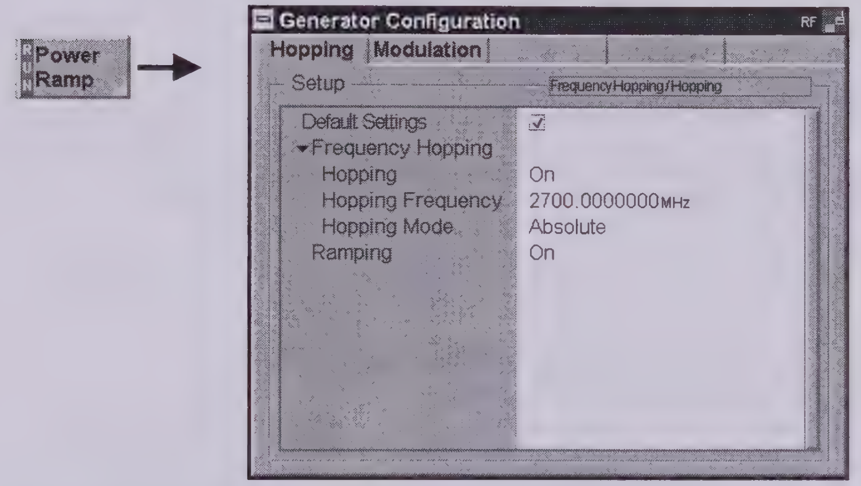
Generator Configuration

The popup menu *Generator Configuration* contains two tabs which configure the RF signal generator. It is opened by pressing the *Generator* softkey in the Analyzer/Generator menu twice. It is possible to change between the tabs by pressing the associated hotkeys.

Power and Frequency Control (Generator Configuration – Hopping)

The tab *Hopping* defines the following characteristics of the RF generator signals:

- Switchover between two frequencies *(Frequency Hopping)*,
- Time dependence of the signal power *(Ramping)*.



Default Settings ☑
Frequency Hopping
Hopping On
Hopping Frequency 2700.0000000 MHz
Hopping Mode Absolute
Ramping On

Fig. 4-14 Generator Configuration – Hopping

Frequency Hopping

The *Frequency Hopping* field defines whether the RF generator generates a signal with a single, constant basic frequency (frequency hopping *Off*) or a signal with two alternating frequencies (frequency hopping *On)* .

The basic frequency is defined via the *Frequency* softkey in the *RF Analyzer/Generator* menu. The second (hopping) frequency can be entered in the *Hopping Frequency* input field. Two definitions of the hopping frequency are provided:

Absolute	The absolute value of the hopping frequency is entered.
Relative	The difference between the hopping frequency and the basic frequency is entered. The resulting absolute frequency, i.e. $f_{abs} = f_{rel} + f_{base}$ must lie in the permissible range for the CMU (see data sheet).

If frequency hopping is selected the RF signal frequency changes after every 4.615 ms: the dwell time at a frequency is as for GSM signals.

Remote control

```
SOURce:RFGenerator:FHOPping:STATe <ON | OFF>
SOURce:RFGenerator:FHOPping:FREQuency <Frequency>
SOURce:RFGenerator:FHOPping:FREQuency:MODE
                                        <ABSolute | RELative>
```

Ramping

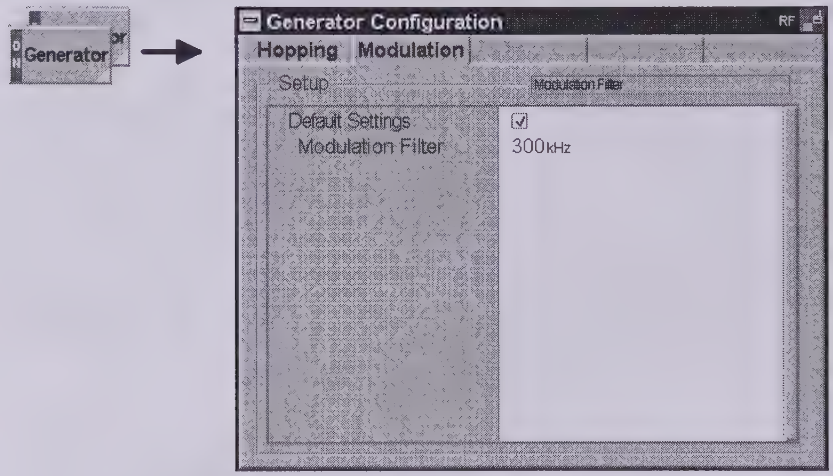
The *Ramping* field defines whether the RF generator generates a continuous, unmodulated signal (CW signal, Ramping is *Off)* or a series of pulses (Ramping is *On)*.

If ramping is selected the CMU generates rectangular, GSM-like pulses with a duration of 577 ms.

Remote control
`SOURce:RFGenerator:PULSe:STATe <ON | OFF>`

Modulation Filter (Generator Configuration – Modulation)

The tab *Modulation* selects the bandwidth of the modulation filter.



Default Settings ☑
Modulation Filter 300 kHz

Fig. 4-15 Generator Configuration – Modulation

Modulation Filter

The *Modulation Filter* field defines the resolution bandwidth of the modulation filter. The bandwidths 30 kHz, 300 kHz or off (corresponding to a broadband modulation filter) can be selected.

In a *Spectrum* measurement a modulation filter suppresses the signals located to the right and to the left of the center frequency.

Remote control
`SOURce:RFGenerator:BANDwidth[:RESolution] <Bandwidth>`

Measurement Menu Power versus Time

The menu group *Power versus Time* comprises the functions for measurement of the signal power as a function of time (oscillographic representation in a restricted frequency range, e.g. for burst analysis). The popup menu *Power versus Time Configuration* is used for configuration of the measurements; the measurement results are displayed in the graphical measurement menu *Power versus Time*.

Measurement Menu (Power versus Time)

The graphical measurement menu *Power versus Time* displays the results of the power measurement in the time domain.

- The main softkey *Power versus Time* controls the measurement, indicates its status *(RUN | HLT | OFF)* and opens the configuration menu *Power versus Time Configuration*. The hotkey associated to the main softkey define the scope of the *Power versus Time* measurement.
- The other softkeys to the right of the test diagram are combined with various hotkeys (e.g. the hotkeys *Frequency* and *RBW* belong to the softkey *Analyzer Settings)*. The softkey/hotkey combinations provide test settings and display configurations.

The measurement menu *Power versus Time* is opened from the main menu *Menu Select* (with the associated key at the front of the instrument) or using the *Power/t* hotkey.

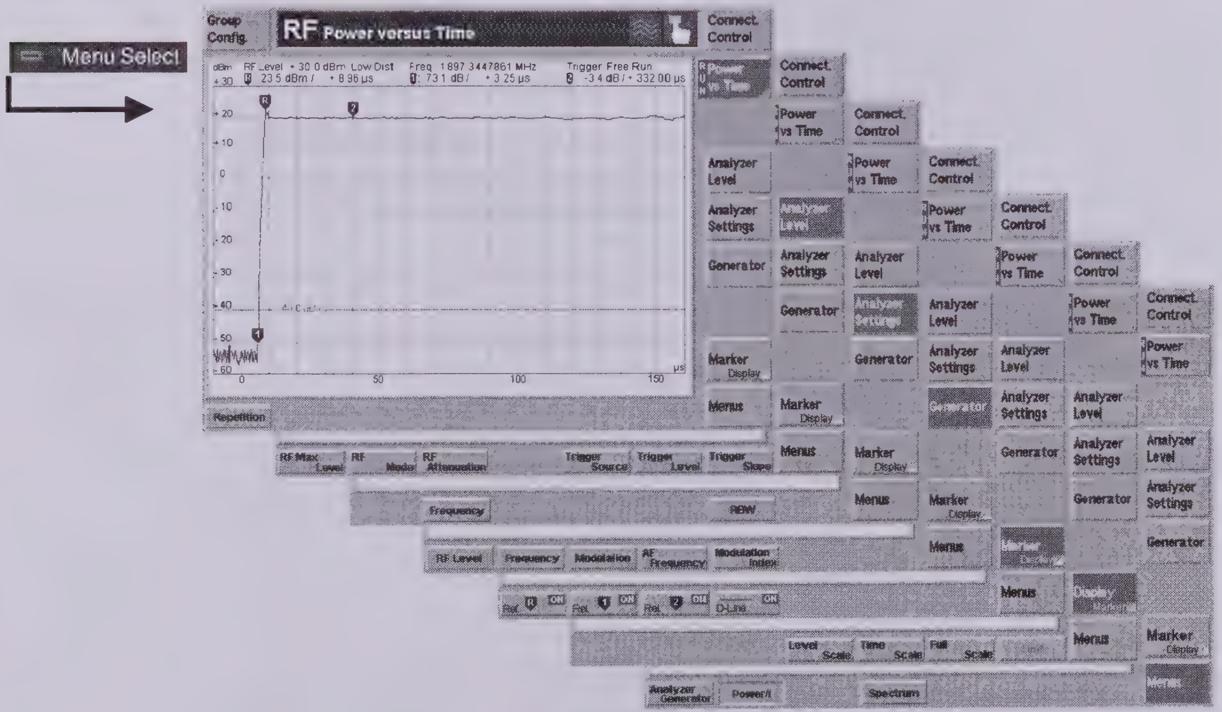

Menu Select
Group Config
RF Power versus Time
Connect. Control
dBm RF Level +30.0 dBm Low Dist
R 23.5 dBm / +8.96 µs
Freq 1.897 3447861 MHz
1: 73.1 dB / +3.25 µs
Trigger Free Run
2 -3.4 dB / +332.00 µs
+30
+20
+10
0
-10
-20
-30
-40
-50
-60
0
50
100
150
µs
Power vs Time
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
Display
Repetition
RF Max Level
RF Mode
RF Attenuation
Trigger Source
Trigger Level
Trigger Slope
Frequency
RBW
RF Level
Frequency
Modulation
AF Frequency
Modulation Index
Rel. R ON
Rel. 1 ON
Rel. 2 ON
D-Line ON
Level Scale
Time Scale
Full Scale
Analyzer Generator
Power/t
Spectrum

Fig. 4-16 Measurement menu Power versus Time

Test settings

The basic settings for the *Power* measurement are directly accessible from the measurement menu via softkey/hotkey combinations. If a softkey is selected and an associated hotkey is pressed, a popup window will appear which indicates the current setting and enables an entry.

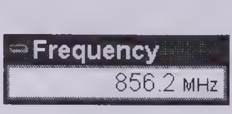
Example:

Analyzer Settings

The Analyzer Settings softkey displays a hotkey bar including the hotkey labeled Frequency.

Frequency

The *Frequency* hotkey opens the input window *Frequency*.



Frequency
856.2 MHz

Input windows indicate the current parameter value (in this case: the frequency of the ongoing measurement) and a list of the possible settings. Parameters are changed by

- overwriting/incrementing numerical values (for numeric parameters),
- selecting from the list of parameters (for select parameters).

Some of the basic settings are also accessible from the *Power versus Time Configuration* popup menu. They are explained in more detail in the *Measurement Configurations (Power versus Time Configuration)* section on page 4.31 ff. All softkeys and hotkeys in the *Power versus Time* menu are shown in Fig. 4-16 on page 4.24.

Power vs Time

The *Power vs Time* softkey controls the power measurement and indicates its status *(RUN | HLT | OFF)*.

This status can be changed after softkey selection (pressing once) by means of the *ON/OFF* key or the *CONT/HALT* key.

Remote control
`INITiate:POWer; ABORt:POWer; STOP:POWer; CONTINUE:POWer`
`FETCh:POWer:STATus?`

Measurement configuration

Pressing the *Power vs Time* softkey twice opens the popup menus *Power vs Time Configuration* (see page 4.31). Besides, the following hotkey defining the scope of the measurement is associated to the *Power vs Time* softkey:

Repetition

The hotkey *Repetition* determines the repetition mode of the measurement (Single Shot or Continuous measurement; see section *Measurement Configurations (Power versus Time Configuration)* section on page 4.31 ff).

Remote control
`CONFigure:POWer:CONTrol:REPetition`
`<Repetition>,<StopCond>,<Stepmode>`

Analyzer Level

The *Analyzer Level* softkey controls the level in the RF input signal path and provides the trigger settings for the *Power* measurement.

The input level settings are described in more detail in section *Input Level (Group Configuration – Input Level)* on page 4.45. The trigger settings are described in more detail in section *Trigger (Group Configuration – Trigger)* on page 4.47.

RF Max. Level

The *RF Max. Level* hotkey sets the maximum expected input level in dBm.

Remote control
`[SENSE:]LEVel:MAXimum <Level>`

RF Mode

The *RF Mode* hotkey determines how the input level is defined.

Manual	Manual input via *RF Max. Level* hotkey
Auto	Automatic setting according to the average burst power of the applied signal.

Remote control
```
[SENSE:]LEVel:MODE  MANual | AUTOmatic
```

RF Attenuation

The *RF Attenuation* hotkey selects a strategy for tuning the RF analyzer.

Normal	Mixer level in normal range.
Low Noise	Enhanced mixer level. This setting ensures the full dynamic range of the CMU and is therefore recommended for *Power* versus time and *Spectrum* measurements.
Low Distortion	Decreased mixer level.

Remote control
```
[SENSe:]LEVel:ATTenuation  NORMal | LNOIse | LDIStortion
```

Trigger Source

The *Trigger Source* hotkey determines the trigger condition; see section *Trigger (Group Configuration – Trigger)* on page 4.47.

Remote control
```
TRIGger[:SEQuence]:SOURce
          FRUN | RFPOWer | IFPOWer | EXTern
```

Trigger Level

The *Trigger Level* hotkey determines the trigger level. This softkey is enabled for trigger source *RF Power* or *IF Power* only; see section *Trigger (Group Configuration – Trigger)* on page 4.47.

Remote control
```
TRIGger[:SEQuence]:THReshold LOW | MEDium | HIGH
```

Trigger Slope

The *Trigger Slope* hotkey determines whether the measurement is triggered by the rising or falling edge of the trigger signal; see section *Trigger (Group Configuration – Trigger)* on page 4.47.

Remote control
```
TRIGger[:SEQuence]:SLOPe POSitive | NEGative
```

Analyzer Settings

The *Analyzer Settings* softkey determines the center frequency of the measured signal and the resolution bandwidth.

Frequency

The *Freq.* hotkey defines the center input frequency for the measurement in MHz. This setting is identical with the frequency setting in the *Analyzer Settings* panel of the *Analyzer/Generator* menu (p. 4.18).

Remote control
```
[SENSe:]POWer:FREQuency:CENTer <Frequency>
```

RBW

The *RBW* hotkey opens the input window for the resolution bandwidth.

The nominal resolution bandwidth is the 3-dB bandwidth of the selection filter. From a list discrete bandwidths between 10 Hz and 1 MHz can be selected. The frequencies in the list are given by $1x10^n$ Hz, $2x10^n$ Hz, $3x10^n$ Hz, $5x10^n$ Hz where n=1 to 5. In addition the value 1 MHz can be selected.

Resolution bandwidths for the analyzer and the *Spectrum* measurement can be set independently (p. 4.18, 4.32).

Remote control
```
[SENSe:]POWer:FREQuency:BANDwidth[:RESolution] <Bandwidth>
[SENSe:]POWer:FREQuency:BWIDth[:RESolution] <Bandwidth>
```

Generator Settings

The *Generator Settings* softkey configures the RF signal generated.

The following generator settings are described in more detail in section *Generator Settings* on page 4.20 ff.

RF Level

The RF Level hotkey defines the absolute RF generator level in dBm.

Remote control
```
SOURce:RFGenerator:LEVel <Level>
```

Frequency

The *Frequency* hotkey defines the frequency of the RF generator signal in MHz.

Remote control
```
SOURce:RFGenerator:FREQuency <Frequency>
```

Modulation

The *Modulation* hotkey defines the frequency of the RF generator signal in MHz.

Remote control
```
SOURce:RFGenerator:MODulation OFF | SSB | AM
```

AF Frequency

The *AF Frequency* hotkey defines an AF frequency which is used for *SSB* or *AM* modulation; see previous hotkey.

Remote control
```
SOURce:RFGenerator:MODulation:SSB:FREQuency <Frequency>
```

Modulation Index

The *Modulation Index* hotkey defines the modulation index for AM modulation.

Remote control
```
SOURce:RFGenerator:MODulation:AM:INDex <ModIndex>
```

Marker Display

The *Marker/Display* softkey positions up to 3 markers and a D-line in the test diagram and displays their values.

If pressed once again, the selected Marker/Display softkey changes to the *Display/Marker* softkey, see below.

Markers	are graphical tools for marking points on the measurement curve and for numerical output of measured values. The measurement menu Power provides a reference marker and two further markers which permit to measure spacings (delta marker 1 and 2). The coordinates of the three markers are indicated in the format Ordinate value (level)/abscissa value (time) in a parameter line above the

	test diagram. The position of the reference marker is expressed in absolute units (level in dBm and time in bits), the delta marker by absolute or relative values (relative level in dB or time differences from the reference marker).
D-line	The D-line (display line) is a horizontal line that can be positioned to mark and read out an arbitrary level in the test diagram.

Ref R

The hotkey *Ref. R* switches the reference marker on or off (use the *ON/OFF* key).

The reference marker is represented by the symbol R in the test diagram. The marker position (abscissa) is defined in the input field *Ref. Marker R*. The marker can be positioned to arbitrary time values. It is switched off in the default setting *(Off)*. The marker level is given by the measurement curve at the marker position.

The position of all markers can be varied using the roll-key.

Remote control
No command, screen configuration only.

Rel 1

The *Rel. 1* hotkey switches the delta marker 1 on or off (use the *ON/OFF* key).

The delta marker 1 is represented by the symbol 1 in the test diagram. The marker position (abscissa) is defined in the input field *Rel. Marker 1*. The marker can be positioned to arbitrary time values. If its position is outside the diagram area it will be invisible and its coordinates will be "<abscissa_value> / - - -". The marker is switched off in the default setting *(Off)*. The marker level is given by the measurement curve at the marker position.

The toggle switch *Rel 1 Config* pops up when the hotkey is pressed for the second time. It defines whether the position of delta marker 1 is measured and indicated in absolute units (dBm) or relative to the reference marker.

Remote control
No command, screen configuration only.

Rel 2

The *Rel. 2* hotkey switches the delta marker 2 on or off (use the *ON/OFF* key). Functions and remote control are analogous to delta marker 1.

D-Line

The *D-Line* hotkey switches the D-line in the test diagram on or off.

The D-line is a horizontal, colored auxiliary line in the test diagram and is used for marking a level value and for measuring level differences. The level (ordinate) is determined in the input field *D-Line* and indicated on the D-line. The permissible value range is the diagram area, the default setting is Off.

The switch *D-Line Config.* is opened by pressing *D-Line* twice and determines whether the D-line level is expressed in absolute units (in dBm, setting absolute) or relative to the Max. Level (in dB, setting relative).

Remote control
No command, screen configuration only.

Display Marker

The *Display/Marker* softkey zooms or shifts the graphical display. It is selected by pressing the *Marker/Display* softkey twice. If pressed once again, the selected *Display/Marker* softkey changes back to the *Marker/Display* softkey, see above.

Level Scale

The *Level Scale* hotkey defines the level range of the *Power versus Time* test diagram (ordinate scale). From the popup window one of the ranges 10 dB, 20 dB, 30 dB, 50 dB, 80 dB or 100 dB can be selected. Note that, in contrast to the reference level, the range selection doesn't have any impact on the measurement.

The ordinate scale is calculated from the maximum level defined in the *Group Config.* menu (page 4.45) and the range such that

- The *Max Level* defines the upper edge of the diagram.
- The difference *Max Level – Level Scale* defines the lower edge of the diagram.
- The number of horizontal grid lines (corresponding to 10, 15, or 16 cells) and the ordinate labeling is adapted to the range.

Remote control

```
[SENSe:]POWer:LEVel:RANGe <Range>
```

Time Scale

The *Time Scale* hotkey defines the time range of the *Power versus Time* test diagram (abscissa scale). The time scale is equal to the total measurement range of the *Power versus Time* measurement.

The time scale is defined by means of the start time and the span of the measurement. The diagram is derived from the start time and the span assuming a constant number of 10 horizontal cells:

- The *delay* defines the left edge of the diagram.
- The *delay + span* defines the right edge of the diagram.
- The abscissa labeling is adapted to the defined time scale.

The delay time is defined relative to the trigger time. The permissible range of delay times depends on the span (see below) and on the resolution bandwidth of the power measurement. As a general rule, larger values are allowed if the span is increased and the resolution bandwidth decreased.

Remote control

```
[SENSe:]POWer:TIME:DELay <Delay>
[SENSe:]POWer:TIME:SPAN <Span>
```

Menus

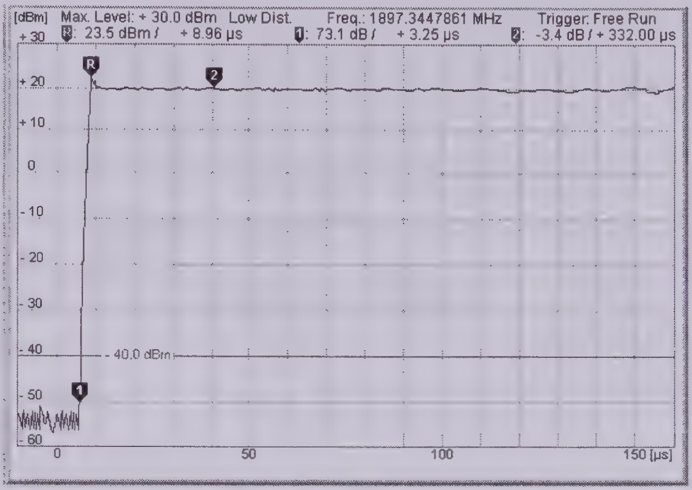
The Menus softkey displays the hotkey bar for switching over to the other measurement menus.

Measurement Results

The values represented in the measurement menu *Power versus Time* can be divided into three groups:

- Setting values
- Scalar measurement results (marker values)
- The trace plotted as a function of time

These values are indicated in two parameter lines and the test diagram:


[dBm] Max. Level: + 30.0 dBm Low Dist. Freq.: 1897.3447861 MHz Trigger: Free Run

R: 23.5 dBm / + 8.96 µs 1: 73.1 dB / + 3.25 µs 2: -3.4 dB / + 332.00 µs

Parameter line 1/2

Test diagram with reference marker, delta marker 1 and 2 and D-line.

Fig. 4-17 Display of measurement results (Power versus Time menu)

Settings/ scalar measurement results

Settings and scalar measurement results are indicated in the two parameter lines above the test diagram

1st parameter line

The first parameter line contains the following settings:

Max. Level	Maximum value of input level set as in *Group Config. – Input Level* (see p. 4.45).
Attenuation	Setting for the attenuation of the input level *(Normal, Low Noise, Low Distortion)* set as in *Group Config. – Input Level* (see p. 4.45).
Freq.	Center frequency of the RF signal analyzed
Trigger	Trigger mode *(Free Run, RF Power, IF Power* or *External)*

2nd parameter line

The second parameter line contains the following marker values:

R	Level and time of reference marker
1	Level and time of delta marker 1 (setting *absolute*) or difference from reference marker (setting *relative*)
2	Level and time of delta marker 2 (setting *absolute*) or difference from reference marker (setting *relative*)

Remote control

Settings are read out using the query corresponding to the setting command (setting command with appended question mark).

To obtain the measurement value at a single point on the trace the whole trace must be read, see below.

Measurement curves (fields)

The measurement curve is displayed as a continuous trace in the test diagram together with the limit lines, markers and the D-line, if defined.

The measurement curve in the *Power versus Time* measurement menu shows the measured burst power (in dBm) as a function of time (in µs). The diagram scale, which is equal to the measurement range, and the displayed result depend on the test settings.

Remote control

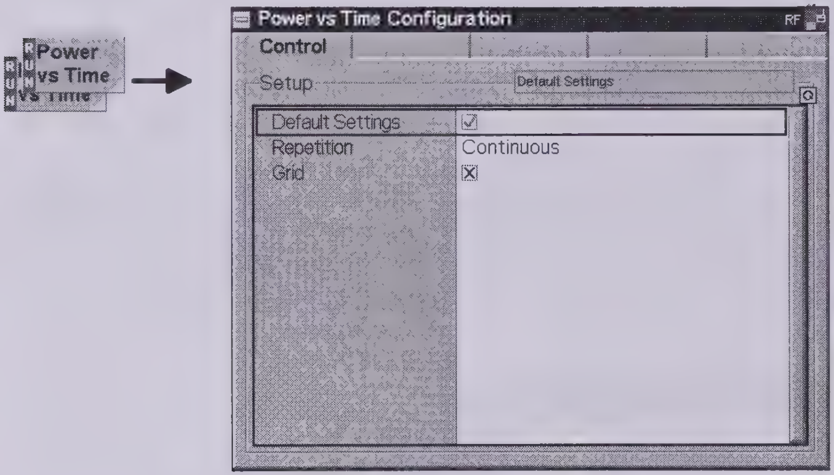
```
READ:ARRay:POWer[:RESult][:CURRent]?
FETCh:ARRay:POWer[:RESult][:CURRent]?
SAMPle:ARRay:POWer[:RESult][:CURRent]?
```

Measurement Configurations (Power versus Time Configuration)

The popup menu *Power versus Time Configuration* determines the parameters of the power measurement. It is activated by pressing the softkey *Power versus Time* in the graphical measurement menu *Power versus Time* twice.

The *Power versus Time Configuration* menu controls the power measurement. It defines:

- The repetition mode *(Repetition).*
- Besides, it influences the power display by adding a *Grid* or not.



Setup: Default Settings

Default Settings	☑
Repetition	Continuous
Grid	☒

Fig. 4-18 Power versus Time Configuration – Control

Repetition

The *Repetition* field determines the repetition mode:

Single Shot	Single-shot measurement: the measurement is stopped after one cycle, i.e. after evaluation of the trace over the entire time range. A stopped measurement is indicated by the status display *HLT* in the *Power versus Time* softkey.
Continuous	Continuous measurement: The CMU measures permanently until the measurement is explicitly stopped via the *Power versus Time* softkey in the graphical measurement menu. The measurement results are valid after one statistic cycle; however, the measurement is continued, and the output is continuously updated. An ongoing measurement is indicated by the status display *RUN* in the *Power versus Time* softkey.

Single shot should always be selected if only a single measurement result is required under fixed conditions. The continuous measurement is suitable for monitoring the evolution of a measured quantity in time, for example for adjustments.

Note: *In remote mode, the counting measurement (counting mode) is available as a further repetition mode with a defined number of measurement cycles to be performed, see chapter 6 of this manual.*

Remote control

```
CONFigure:POWer:CONTrol:REPetition
     CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Grid

The *Grid* box switches on or off the grid in the graphical test diagram.

Remote control

```
CONFigure:POWer:CONTrol:GRID  ON | OFF
```

Measurement Menu Spectrum

The menu group *Spectrum* measures the signal power as a function of the frequency (spectrum analysis). The popup menu *Spectrum Configuration* is used for configuration of the measurements; the results (i.e. the spectrum) are displayed in the graphical measurement menu *Spectrum.*

Measurement Menu (Spectrum)

The graphical measurement menu *Spectrum* displays the results of the spectrum analysis (measurement of signal power as a function of the frequency).

- The main softkey *Spectrum* controls the measurement, indicates its status *(RUN | HLT | OFF)* and opens the configuration menu *Spectrum Configuration* (press twice). The hotkey associated to the main softkey defines the scope of the *Spectrum* measurement.
- The other softkeys to the right of the test diagram are combined with various hotkeys. If a softkey is selected and an associated hotkey pressed, a popup window will appear which indicates the current setting and enables an entry (see section *Measurement Menu (Power versus Time)* on page 4.24).

The measurement menu *Spectrum* is opened from the main menu *Menu Select* (with the associated key at the front of the instrument) or using the *Spectrum* hotkey.

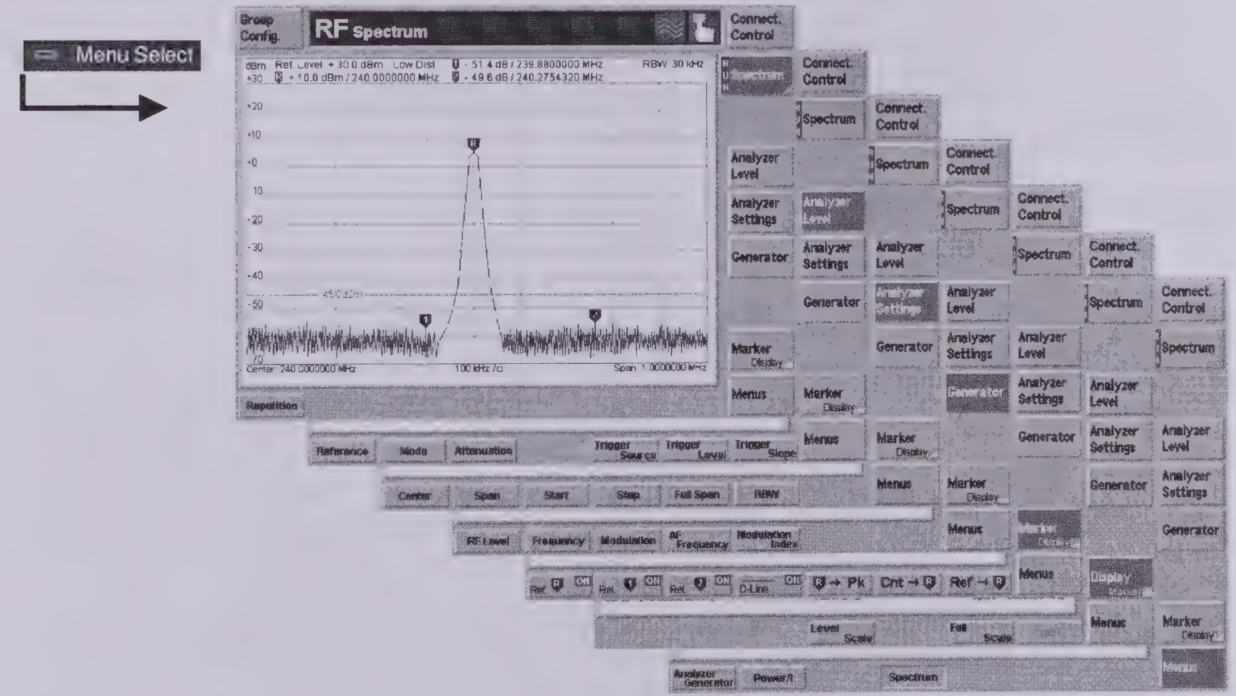

Menu Select
Group Config.
RF Spectrum
Connect. Control
dBm Ref. Level + 30.0 dBm Low Dist
+30 + 10.0 dBm / 240.0000000 MHz
- 51.4 dB / 239.8800000 MHz
- 49.6 dB / 240.2754320 MHz
RBW 30 kHz
Center 240.0000000 MHz
100 kHz /D
Span 1.0000000 MHz
Repetition
Spectrum
Analyzer Level
Analyzer Settings
Generator
Marker Display
Menus
Reference
Mode
Attenuation
Trigger Source
Trigger Level
Trigger Slope
Center
Span
Start
Stop
Full Span
RBW
RF Level
Frequency
Modulation
AF Frequency
Modulation Index
D-Line
→ Pk
Cnt →
Ref →
Level Scale
Full Scale
Analyzer Generator
Power/t
Spectrum

Fig. 4-19 Measurement menu Spectrum

Test settings

The *Generator* test settings and the *Menus* softkey are identical with the corresponding softkeys in the *Power* menu. The *Spectrum* softkey is analogous to the *Power vs Time* softkey (see section *Test settings* on page 4.24). The following softkey/hotkey combinations differ from the *Power versus Time* measurement:

Analyzer Level

The *Analyzer Level* softkey controls the level in the RF input signal path and provides the trigger settings for the *Power* measurement.

The input level settings are described in more detail in section *Input Level (Group Configuration – Input Level)* on page 4.45. The trigger settings are described in more detail in section *Trigger (Group Configuration – Trigger)* on page 4.47.

Reference

The *Reference* hotkey defines the reference level.

The reference level defines the upper edge of the diagram. It is generally different from the maximum input level set in the *Group Config.* menu, see section *Input Level (Group Configuration – Input Level)* on page 4.45.

Remote control
```
[SENSe:]LEVel:REFerence  <LEVel>
```

RF Mode

The *RF Mode* hotkey determines how the input level is defined.

Manual	Manual input via *RF Max. Level* hotkey
Auto	Automatic setting according to the average burst power of the applied signal.

Remote control
```
[SENSE:]LEVel:MODE  MANual | AUTOmatic
```

RF Attenuation

The *RF Attenuation* hotkey selects a strategy for tuning the RF analyzer.

Normal	Mixer level in normal range.
Low Noise	Enhanced mixer level. This setting ensures the full dynamic range of the CMU and is therefore recommended for *Power* versus time and *Spectrum* measurements.
Low Distortion	Decreased mixer level.

Remote control
```
[SENSe:]LEVel:ATTenuation  NORMal | LNOIse | LDIStortion
```

Trigger Source

The *Trigger Source* hotkey determines the trigger condition; see section *Trigger (Group Configuration – Trigger)* on page 4.47.

Remote control
```
TRIGger[:SEQuence]:SOURce
           FRUN | RFPOWer | IFPOWer | EXTern
```

Trigger Level

The *Trigger Level* hotkey determines the trigger level. This softkey is enabled for trigger source *RF Power* or *IF Power* only; see section *Trigger (Group Configuration – Trigger)* on page 4.47.

Remote control
```
TRIGger[:SEQuence]:THReshold LOW | MEDium | HIGH
```

Trigger Slope

The *Trigger Slope* hotkey determines whether the measurement is triggered by the rising or falling edge of the trigger signal; see section *Trigger (Group Configuration – Trigger)* on page 4.47.

Remote control
```
TRIGger[:SEQuence]:SLOPe POSitive | NEGative
```

Analyzer Settings

The *Analyzer Settings* softkey determines the frequency range that is measured and displayed and the resolution bandwidth of the spectrum analyzer.

In addition to the frequency range, the number of vertical grid lines can be selected; see section *Measurement Configurations (Spectrum Configuration)* on page 4.38.

A single measurement of the signal power over the whole frequency range (span, sweep width) by means of a spectrum analyzer is called a sweep. Typically, the minimum sweep time T_{min} is linked to the resolution bandwidth B of the analyzer and the frequency range F by the relation $T_{min} \sim F/B^2$. This means that a compromise between a high resolution, wide frequency range and high measurement speed must be reached.

The frequency range can be set in three different ways:

- By defining the center frequency f_c and the span Δf. The start and stop frequencies are thus given by $f_{start} = f_c - \Delta f/2$ and $f_{stop} = f_c + \Delta f/2$. This mode is convenient if the spectrum is to be analyzed in the vicinity of a known frequency which can be used as the center frequency of the diagram.
- By defining the start frequency f_{start} and the stop frequency f_{stop}. The center frequency and span are thus given by $f_c = (f_{start} + f_{stop})/2$ and $\Delta f = f_{stop} - f_{start}$.
- By selecting *Full Span* the default frequency range is displayed, i.e. the default start and stop frequencies are selected.

The number of vertical grid lines (i.e. the number of cells in horizontal direction) can be variable (depending on the frequency span) or fixed, see *Spectrum Configuration* menu on page 4.38.

Center

The *Center* hotkey defines the center input frequency of the analyzer in MHz or in another frequency unit selected via the unit keys..

Remote control
`[SENSe:]SPECtrum:FREQuency:CENTer <Frequency>`

Span

The *Span* hotkey defines the sweep span.

Remote control
`[SENSe:]SPECtrum:FREQuency:SPAN <Frequency>`

Start

The *Start* hotkey defines the start frequency of the sweep.

Remote control
`[SENSe:]SPECtrum:FREQuency:STARt <Frequency>`

Stop

The *Stop* hotkey defines the stop frequency of the sweep.

Remote control
`[SENSe:]SPECtrum:FREQuency:STOP <Frequency>`

Full Span

The *Full Span* hotkey sets the default sweep span.

On pressing the *Full Span* hotkey the abscissa of the spectrum diagram is changed, and the resolution bandwidth is set to *Auto*. However, the previous scaling parameters and resolution bandwidth are stored and the inscription of the *Full Span* hotkey changes to Last Span. The *Last Span* hotkey allows the previous scaling parameters and resolution bandwidth to be recalled and the previous diagram to be restored.

Remote control
Set *Start* and *Stop* to their default values. Resolution bandwidth see below.

RBW

The *RBW* hotkey defines the resolution bandwidth for the *Spectrum* measurement.

The nominal resolution bandwidth is the 3-dB bandwidth of the selection filter. From a list discrete bandwidths between 10 Hz and 1 MHz can be selected. The frequencies in the list are given by $1x10^n$ Hz, $2x10^n$ Hz, $3x10^n$ Hz, $5x10^n$ Hz where n=1 to 5. In addition the two values 1 MHz and *Auto* can be selected.

With the *Auto* setting the resolution bandwidth is automatically adapted to

bandwidth = span/50

(if this value is inside the allowed range).

Resolution bandwidths for the analyzer and the *Power versus Time* measurement can be set independently (p. 4.18, 4.24).

Remote control

```
[SENSe:]SPECtrum:FREQuency:BANDwidth[:RESolution] <Bandwidth>
[SENSe:]SPECtrum:FREQuency:BWIDth[:RESolution] <Bandwidth>
```

Marker Display

The *Marker/Display* softkey positions up to 3 markers and a D-line in the test diagram and displays their values.

If pressed once again, the selected Marker/Display softkey changes to the *Display/Marker* softkey, see below.

Markers	are graphical tools for marking points on the measurement curve and for numerical output of measured values. The measurement menu Power provides a reference marker and two further markers which permit to measure spacings (delta marker 1 and 2). The coordinates of the three markers are indicated in the format Ordinate value (level)/abscissa value (time) in a parameter line above the test diagram. The position of the reference marker is expressed in absolute units (level in dBm and time in bits), the delta marker by absolute or relative values (relative level in dB or time differences from the reference marker).
D-line	The D-line (display line) is a horizontal line that can be positioned to mark and read out an arbitrary level in the test diagram.

Ref. R

The hotkey *Ref. R* switches the reference marker on or off.

The reference marker is represented by the symbol R in the test diagram. The marker position (abscissa) is determined in the input field *Ref. Marker R*. The marker can be positioned to arbitrary frequency values. If its position is outside the diagram area it will be invisible and its coordinates will be "- - - / <abscissa_value>". The marker is switched off by default. The marker level is given by the trace at the marker position.

The position of all markers can be varied using the rotary knob.

Remote control
No command, screen configuration only

Rel. 1

The *Rel. 1* hotkey switches the delta marker 1 on or off.

The delta marker 1 is represented by the symbol 1 in the test diagram. The marker position (abscissa) is determined in the input field *Rel. Marker 1*. The marker can be positioned to arbitrary frequency values. If its position is outside the diagram area it will be invisible and its coordinates will be "- - - / <abscissa_value>". The marker is switched off by default. The marker level is given by the trace at the marker position.

The toggle switch *Delta Config.1* is opened by pressing *Rel. 1* twice and defines whether the second parameter line shows the absolute position of the delta marker (*absolute*, in dBm and time units) or its distance to the reference marker (*relative*, in dB and time units). If *absolute* is selected the inscription of the *Rel. 1* hotkey changes to *Abs. 1*.

Remote control
No command, screen configuration only

Rel. 2

The *Rel. 2* hotkey switches the delta marker 2 on or off.

Functions are analogous to delta marker 1.

D-Line

The *D-Line* hotkey switches the D-line in the test diagram on or off.

The D-line is a horizontal, colored auxiliary line in the test diagram and is used for marking a level value and for measuring level differences. The level (ordinate) is determined in the input field *D-Line* and indicated on the D-line. The permissible value range is the diagram area, the default setting is *Off.*

The switch *D-Line Config.* is opened by pressing *D-Line* twice and determines whether the D-line level is expressed in absolute units (in dBm, setting absolute) or relative to the Max. Level (in dB, setting relative).

Remote control
No command, only screen configuration

R → Pk

The hotkey *R to Pk* places the reference marker to the maximum of the trace.

Cnt→ R

The hotkey *Cnt to R* centers the diagram to the frequency of the reference marker.

Ref→ R

The hotkey *Ref to R* sets the reference level to the current marker position. It is recommended to use the three softkeys *R to Pk, Cnt to R* and Ref to R in succession to obtain a standard scale for the diagram.

Display Marker

The *Display/Marker* softkey zooms or shifts the graphical display. It is selected by pressing the *Marker/Display* softkey twice. If pressed once again, the selected *Display/Marker* softkey changes back to the *Marker/Display* softkey, see above.

Level Scale

The *Level Scale* hotkey defines the level range of the *Spectrum* test diagram (ordinate scale). From the popup window one of the ranges 10 dB, 20 dB, 30 dB, 50 dB, 80 dB or 100 dB can be selected.

The ordinate scale is calculated from the *Reference* level (see above) and the range such that

- The *Reference* level defines the upper edge of the diagram.
- The difference *Reference* level – *Level Scale* defines the lower edge of the diagram.
- The number of horizontal grid lines (corresponding to 10, 15, or 16 cells) and the ordinate labeling is adapted to the range.

Remote control
`[SENSe:]POWer:LEVel:RANGe <Range>`

Menus

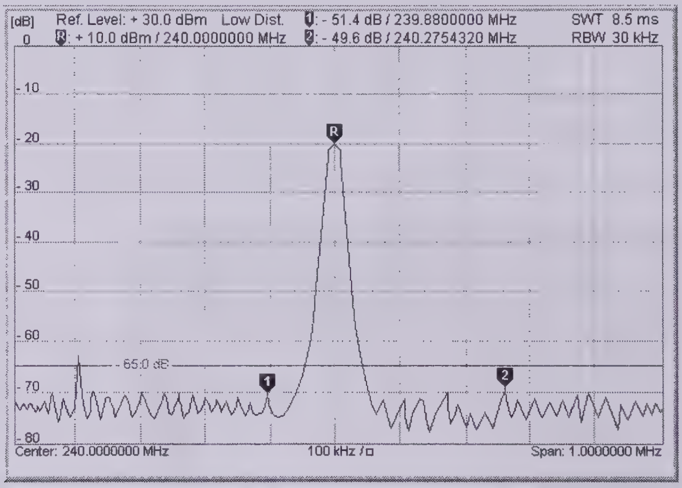
The Menus softkey displays the hotkey bar for switching over to the other measurement menus.

Measurement Results

The values represented in the measurement menu *Spectrum* can be divided into three groups:

- Setting values
- Scalar measurement results (marker values)
- The trace plotted as a function of time

These values are indicated in two parameter lines and the test diagram:



[dB] Ref. Level: + 30.0 dBm Low Dist. 1: - 51.4 dB / 239.8800000 MHz SWT 8.5 ms
0 R: + 10.0 dBm / 240.0000000 MHz 2: - 49.6 dB / 240.2754320 MHz RBW 30 kHz

Parameter line 1/2

Test diagram with reference marker, delta marker 1 and 2 and D-line.

Abscissa labels

Fig. 4-20 Display of measurement results (Spectrum menu)

Settings/ scalar measurement results

Settings and scalar measurement results are indicated in the two parameter lines above the test diagram

1st parameter line

The first parameter line contains the following settings:

Ref. Level	Maximum value of input level set in the *Group Configuration* menu (see page 4.45).
1	Level and time of delta marker 1 (setting *absolute*) or difference from reference marker (setting *relative*)
RBW	Resolution bandwidth (Auto or numeric value)

2nd parameter line

The second parameter line contains the following marker values:

R	Level and time of reference marker
2	Level and time of delta marker 2 (setting *absolute*) or difference from reference marker (setting *relative*)

Remote control
Settings are read out using the query corresponding to the setting command (setting command with appended question mark).

To obtain the measurement value at a single point on the trace the whole trace must be read, see below.

Measurement curves (fields)

The measurement curve is displayed as a continuous trace in the test diagram together with the limit lines, markers and the D-line, if defined.

The measurement curve in the *Spectrum* measurement menu shows the measured burst power (in dBm) in spectral representation, i.e. as a function of the frequency (in MHz). The displayed result depends on the test settings made before.

Remote control
```
READ:ARRay:POWer[:RESult][:CURRent]?
FETCh:ARRay:POWer[:RESult][:CURRent]?
SAMPle:ARRay:POWer[:RESult][:CURRent]?
```

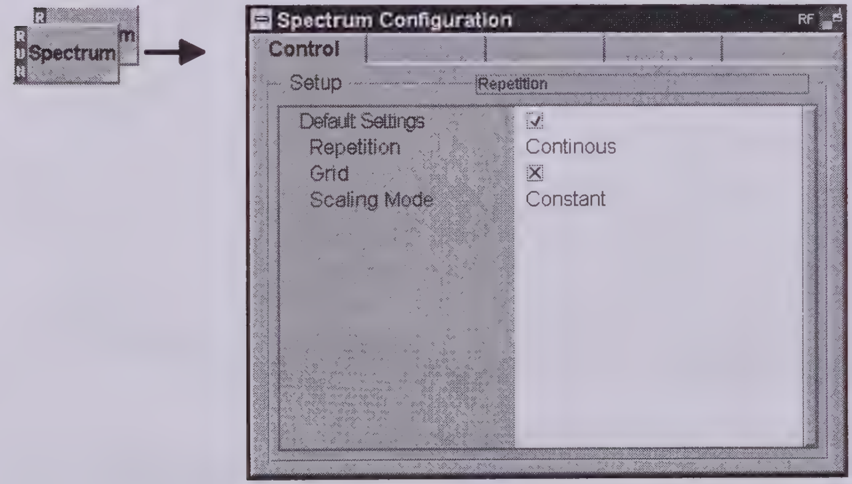
Measurement Configurations (Spectrum Configuration)

The popup menu *Spectrum* determines the parameters of the spectrum analysis. It is activated by pressing the softkey *Spectrum* in the graphical measurement menu *Spectrum* twice.

The *Spectrum Configuration* menu controls the spectrum analysis. It defines:

- The repetition mode *(Repetition)*.

Besides, it influences the spectrum display by adding a *Grid* with configurable cells or not.



Setup: Repetition

Default Settings	☑
Repetition	Continous
Grid	☒
Scaling Mode	Constant

Fig. 4-21 Spectrum Configuration – Control

The functions of this menu comply with those of the menu *Control* in the menu group *Power versus Time* (see page 4.31). In the remote-control commands, the keyword `POWer` is to be replaced by `SPECtrum`.

Repetition

The *Repetition* field determines the repetition mode, see chapter 3 and explanations given on page 4.31 for the *Power versus Time* measurement.

Remote control
```
CONFigure:SPECtrum:CONTrol:REPetition
      CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Grid / Scaling Mode	The *Grid* box switches on or off the grid in the graphical test diagram. In addition the *Scaling Mode*, i.e. the number of grid cells in horizontal direction (frequency axis) can be selected:

Variable	The number of horizontal grid cells is adapted to the sweep span of the *Spectrum* measurement, see page 4.34,
Constant	The diagram consists of a constant number of 10 horizontal grid cells.

Remote control

```
CONFigure:SPECtrum:CONTrol:GRID  ON | OFF
```

Popup Menu Connection Control

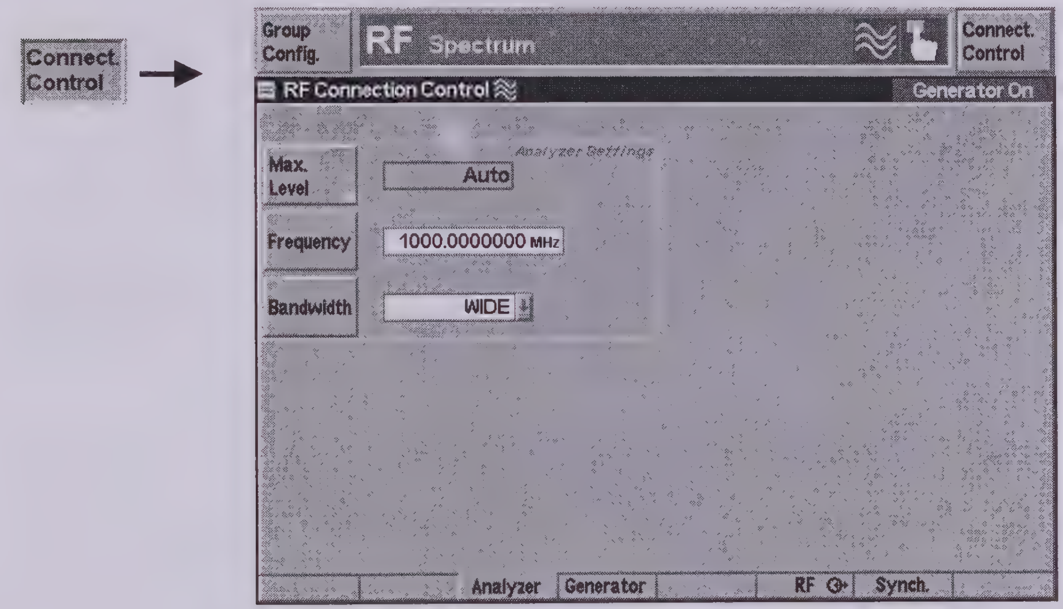
The popup menu *Connection Control* consists of three tabs which configure the inputs and outputs of the CMU and the respective signals in the function group *RF*.

The menu group is activated via the softkey *Connect. Control* to the right of the header of each measurement menu. The individual tabs *(Signal, RF ⊕↔* and *Synch.)* can be selected via the hotkey bar at the lower edge of the screen.

Analyzer Settings (Connection Control – Analyzer)

The *Analyzer* tab determines the maximum input level *(Max. Level)*, the *Frequency* and the resolution *Bandwidth* of the RF analyzer.

All the setting values of this menu are also displayed in the main menu *Analyzer/Generator* (see page 4.18 ff).



Max. Level: Auto
Frequency: 1000.0000000 MHz
Bandwidth: WIDE

Fig. 4-22 Connection Control – RF analyzer Settings

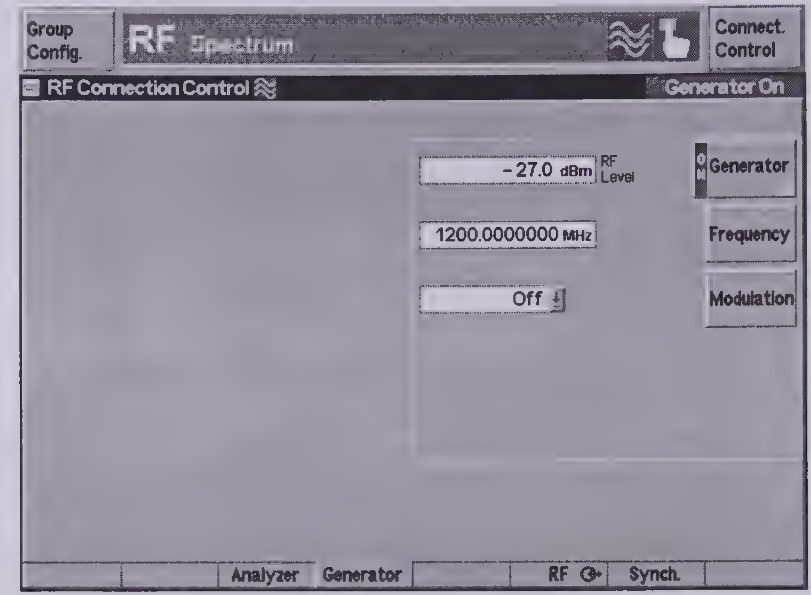
Control of Input and Output Signals (Connection Control – Generator)

The tab *Generator* configures the RF generator. The CMU generates sine wave signals which can be configured as follows:

- Level and frequency of the generator signal *(RF Level, Frequency)*
- Offset frequency or amplitude modulation of the generator signal *(Modulation, SSB Frequency, Modulation Index)*

All the setting values of this menu are also displayed in the main menu *Analyzer/Generator* (see page 4.18).

Connect. Control →


Group Config.
RF Spectrum
Connect. Control
RF Connection Control
Generator On
Generator
Frequency
Modulation
Analyzer
Generator
RF
Synch.

-27.0 dBm RF Level

1200.0000000 MHz

Off

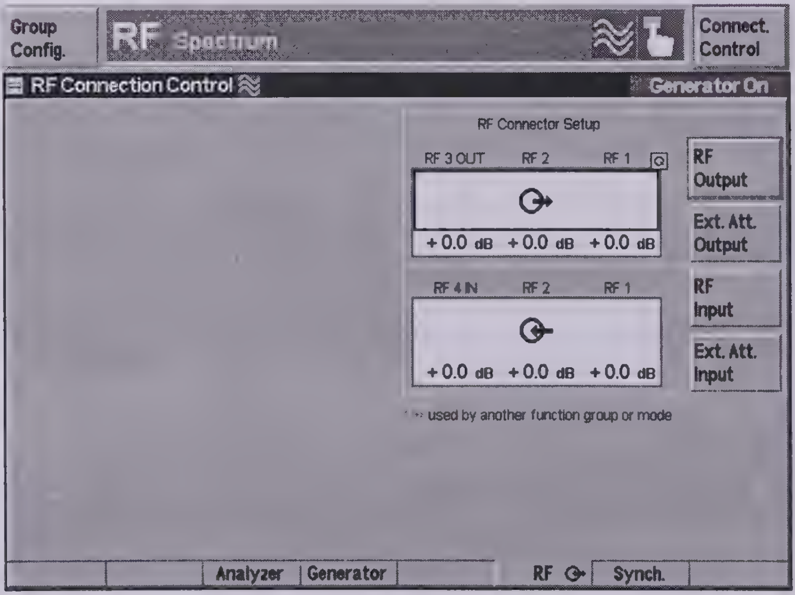
Fig. 4-23 Connection Control – RF generator settings

RF Connectors (Connection Control – Connector/Ext. Att.)

The tab *RF* configures the connectors for RF signals. This includes the setting of

- The RF input and output of the CMU *(RF Output, RF Input)*
- An external attenuation at the connectors (Ext. Att. Output, Ext. Att. Input)

Connect. Control →


Group Config.
RF Spectrum
Connect. Control
RF Connection Control
Generator On
RF Connector Setup
RF Output
Ext. Att. Output
RF Input
Ext. Att. Input
Analyzer
Generator
RF
Synch.

RF 3 OUT	RF 2	RF 1
+0.0 dB	+0.0 dB	+0.0 dB

RF 4 IN	RF 2	RF 1
+0.0 dB	+0.0 dB	+0.0 dB

used by another function group or mode

Fig. 4-24 Connection Control – RF connectors

RF Output

The RF Output softkey defines which of the three connectors RF 1, RF 2 and RF 3 OUT is to be used as RF output connector.

The selected RF output is indicated by a ⊖→ symbol.

Note: *Input and output connectors can be combined at will. The bidirectional connectors RF 1 and RF 2 can be selected as RF inputs and outputs at the same time.*

The LEDs on the front panel are only „on“ (light) if the output level is switched on.

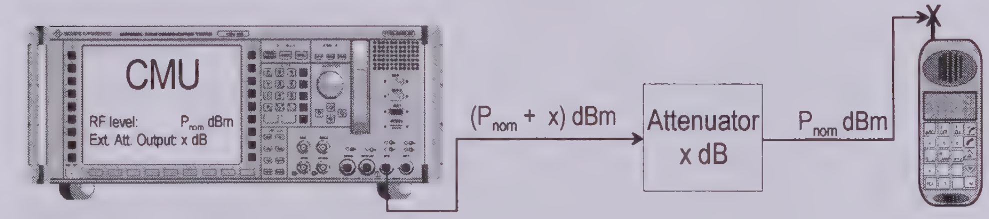
Remote control
`OUTPut[:STATe] RF1 | RF2 | RF3`

Ext. Att. Output

The softkey *Ext. Att. Output* defines an external attenuation (or gain, if the value is negative) at the selected RF output.

Input of an external attenuation is suitable if, e.g., a path attenuation (cable) is included in the test setup, which is to be compensated for by an increased signal level.

If an external attenuation is defined, the output signal level is referenced to the input of the DUT, the generator level is therefore shifted with respect to the actual level at the input connector of the CMU. The default value for the generator power and the level ranges for the RF outputs are also shifted provided that the generator can output the required power, compensating for the external attenuation or gain. Otherwise it is adapted to the level closest to the shifted default value.



Remote control
`[SENSe:]CORRection:LOSS:INPut<nr>[:MAGNitude]`
`SOURce:CORRection:LOSS:INPut<nr>[:MAGNitude] <Loss>`

RF Input

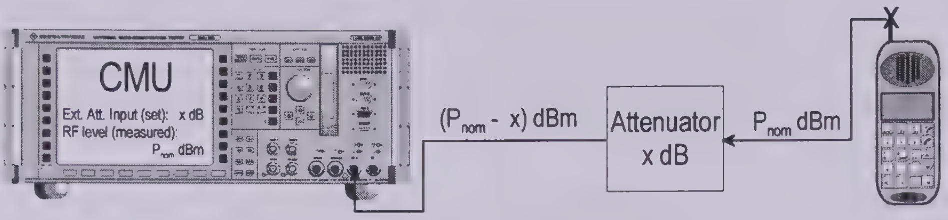
The RF Input softkey determines which of the three connectors RF 1, RF 2 and RF 4 IN is to be used as RF input connector. The selected RF output is indicated by a ⊖ symbol. Input and output connectors can be arbitrarily combined.

Remote control
INPut[:STATe] RF1 | RF2 | RF4

Ext. Att. Input

The softkey Ext. Att. Input enters the value of the external attenuation (or gain) at the selected RF input.
Input of an external attenuation is required if, for example, external attenuator pads are used for protection of the sensitive RF inputs of the CMU or if a path attenuation is included in the test setup.

If an external input attenuation is reported to the instrument, all levels measured are referenced to the output of the DUT and therefore shifted with respect to the actual level at the input connectors of the CMU. The level ranges for the input connectors are shifted as well.


CMU
Ext. Att. Input (set): x dB
RF level (measured):
P_{nom} dBm
$(P_{nom} - x)$ dBm
Attenuator
x dB
P_{nom} dBm

Note: *The LEDs on the front panel are only "on" (light) if the measurement is active.*

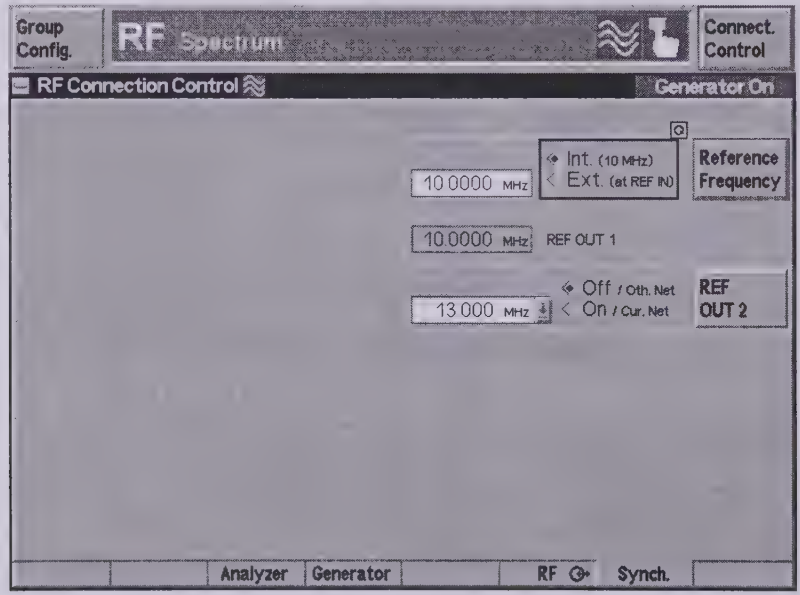
Remote control
```
[SENSe:]CORRection:LOSS:OUTPut<nr>[:MAGNitude]
SOURce:CORRection:LOSS:OUTPut<nr>[:MAGNitude] <Loss>
```

Reference Frequency (Connection Control – Synch.)

The tab *Synch.* determines the reference signals for synchronization. This includes

- The internal or external *Reference Frequency*
- The output mode for the network-specific system clock *(REF OUT 2)*.

Connect. Control →


Group Config.
RF Spectrum
Connect. Control
RF Connection Control
Generator On
Analyzer
Generator
RF
Synch.

Reference Frequency: ● Int. (10 MHz) ○ Ext. (at REF IN) — 10.0000 MHz

REF OUT 1: 10.0000 MHz

REF OUT 2: ● Off / Oth. Net ○ On / Cur. Net — 13.000 MHz

Fig. 4-25 Connection Control – Synchronization

Reference Frequency

The Reference Frequency softkey determines the source and the frequency of the reference signal.

The associated field permits to select between two alternatives:

Int. (10 MHz)	internal synchronization with 10 MHz (TCXO or OCXO, CMU-B11/-B12) applied to output REF OUT 1 at the rear of the instrument.
Ext. (at REF IN)	external reference signal to be fed in via input REF IN and applied to output REF OUT 1 at the rear of the instrument.

The frequency of the external reference signal must be entered in the input field next to the *External* button.

The reference signal used is applied to output *REF OUT 1* so that it can be fed to other instruments as well. It can be used for synchronization to another instrument.

Note:

1. *The header cyclically displays a warning if no synchronization has been performed e.g. because of missing or faulty input signal with external synchronization selected.*
2. *In the case of external synchronization with squarewave signals (TTL) ensure correct signal matching to avoid reflections. Otherwise, resulting overshoots may cause trigger problems at the CMU input. A possible remedy is to use a lowpass filter or an attenuator pad directly at the CMU input. Correct synchronization may be checked by comparing the signal REF OUT 1 with the input signal.*
3. *This configuration is valid in all CMU function groups.*

Remote control
`CONFigure:SYNChronize:FREQuency:REFerence:MODE <ON | OFF>`
`CONFigure:SYNChronize:FREQuency:REFerence <Frequency>`

REF OUT 2

The softkey REF OUT 2 configures a network-specific system clock REF OUT 2 to be fed to the output REF OUT 2 at the rear of the instrument.

The associated field permits to select between two alternatives:

OFF (other network)	The clock frequency of the current function group is not fed to the output REF OUT 2. With this setting the system clock of another active function group (e.g. the network GSM1800 while the current network is GSM900) is still applied to REF OUT 2 provided that the output REF OUT 2 is switched on in the other function group. However, if REF OUT 2 is explicitly switched over from On to Off the clock signal is definitely removed.
On (current network)	The network-specific system clock of the current function group is fed to output REF OUT 2. The system clock of any other function group applied to REF OUT 2 before is replaced.

Besides the basic clock frequency of 39 MHz one of the following clock frequencies may be selected:

40.000 MHz, 20,000 MHz, 13.334 MHz, 10.000 MHz, 8.000 MHz, 6.667 MHz, 5.715 MHz,
5.000 MHz, 4.445 MHz, 4.000 MHz, 3.637 MHz, 3.334 MHz, 3.077 MHz, 2.858 MHz,
2.667 MHz, 2.500 MHz, 2.353 MHz, 2.223 MHz, 2.106 MHz, 2.000 MHz, 1.905 MHz,
1.819 MHz, 1.740 MHz, 1.667 MHz, 1.600 MHz, 1.539 MHz, 1.482 MHz, 1.429 MHz,
1.380 MHz, 1.334 MHz, 1.291 MHz, 1.250 MHz

(The values are calculated according to the formula $F_{out\,0} = 40.000\ MHz / n$ where $n = 1, ..., 32$.)

The clock frequency can be used to synchronize other instruments.

Remote control
`SOURce:DM:CLOCk:STATe ON | OFF`
`SOURce:DM:CLOCk:FREQuency <Frequency>`

Popup Menu Group Configuration

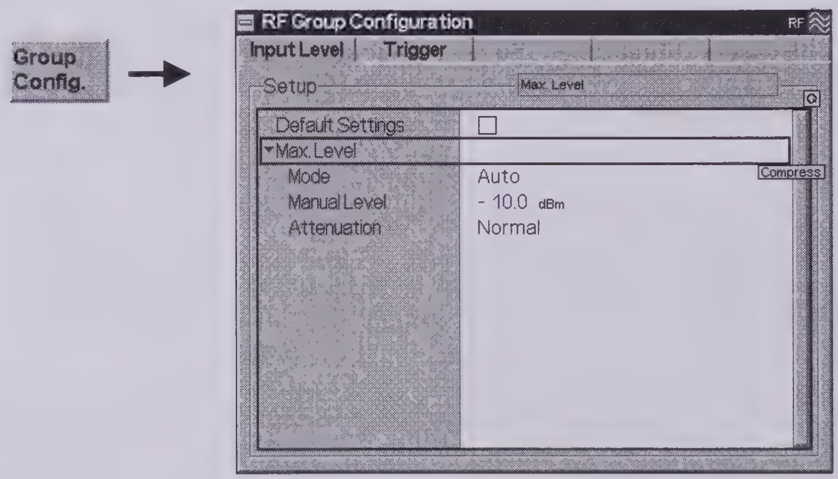
The popup menu *Group Configuration* contains two tabs which configure the measurements in the function group RF globally, i.e., it provides settings that are valid for all measurement menus within the function group. Most of these settings can be overwritten in the individual graphical measurement menus using softkeys and popup input fields.

The popup menu *Group Configuration* can be activated by pressing the softkey *Group Config.* at the top left in each measurement menu. It is possible to change between the tabs by pressing the associated hotkeys.

Input Level (Group Configuration – Input Level)

The tab *Input Level* provides settings for the measured input level (see also section *Popup Menu Connection Control* on page 4.40 ff.):

- Maximum value *(Max. Level)*
- Attenuation *(Attenuation)*



Default Settings ☐
Max. Level
Mode Auto
Manual Level - 10.0 dBm
Attenuation Normal

Fig. 4-26 Group Configuration – Input level

Max. Level The *Max. Level* field sets the input attenuator and thus determines the maximum permissible input level (overload level). The maximum input level determines the upper edge of the diagram in the graphical menu *Power versus Time* and is also displayed next to the softkey *Max. Level* in the main menu *Analyzer/Generator* (see page 4.18). The upper edge of the *Spectrum* diagram is set independently via the *Reference* hotkey, see section *Test settings* on page 4.32.

Mode The *Mode* field determines how the maximum input level is set:

Manual	Manual input of maximum input level
Auto	Automatic setting of maximum input level (autoranging) according to the power of the applied signal.

Remote control
`[SENSe:]LEVel:MODE MANual | AUTOmatic`

The value range depends on the selected RF input (see section "Control of Input and Output Signals (Connection Control – Generator)" on page 4.40):

External attenuation	If an external input attenuation is reported to the instrument (see section *RF Connectors (Connection Control – Connector/Ext. Att.)* on page 4.41), all levels measured are referenced to the output of the DUT and therefore shifted with respect to the actual level at the input connectors of the CMU. The level ranges for the input connectors are shifted as well.

Input levels exceeding the *Max. Level* can not be measured; the corresponding measurement result fields indicate invalid results "– – –".

Error messages

If the value determined for *Max. Level* is too high or too low, a window with the error message *"<Max_Level> is out of range. <permissible max. value> is limit."* and three fields will appear:

Accept	The permissible max. value is accepted as Max. Level,
Re-edit	Max. Level is entered once again,
Cancel	The last valid input value is maintained.

When switching over to another input, the current value of *Max. Level* is automatically adapted, if required:

- Towards lower values to the maximum permissible value of the new input,
- Towards upper values to the minimum value of the new input.

Note: *A maximum input level can be entered even if automatic level setting (autoranging) is selected. The entered level is used as a start value for the autoranging routine and is also important to ensure safe switchover to manual setting.*

Remote control

`[SENSe:]LEVel:MAXimum <Level>`

Attenuation

The *Attenuation* field defines how the RF analyzer of the CMU is tuned to meet the requirements of the current measurement type. In general, a compromise between the acceptable noise level in the displayed result and the contribution of internally generated distortion must be reached.

Normal	Mixer level in normal range,
Low noise	Mixer level enhanced by +10 dB (full dynamic range of CMU, therefore recommended for *Power* versus time and *Spectrum* measurements),
Low distortion	Mixer level reduced by –10 dB (high intermodulation spacing, therefore recommended for modulation measurements).

The *Attenuation* setting permits the CMU to be adapted to the requirements of the measurement. The advantages and disadvantages of the settings *Low noise* and *Low distortion* are listed in the following table.

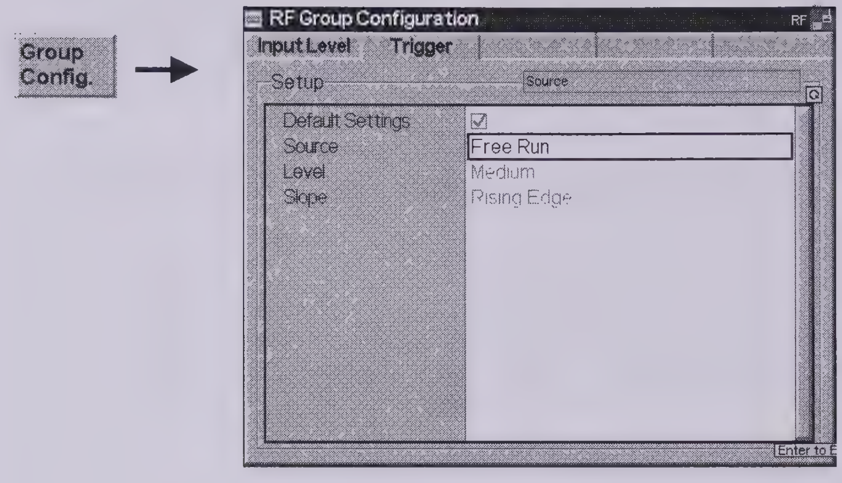
	Advantages	**Disadvantages**
Low noise	Low noise high dynamic range	No RF overdrive reserve Risk of intermodulation
Low distortion	High intermodulation spacing	Lower dynamic range

Remote control

`[SENSe:]LEVel:ATTenuation  NORMal | LNOise | LDIStortion`

Trigger (Group Configuration – Trigger)

The tab *Trigger* defines the trigger condition for the measurement.



Default Settings ☑
Source Free Run
Level Medium
Slope Rising Edge

Fig. 4-27 Group Configuration – Trigger

Default The field *Default* assigns the default setting to all fields of the tab *Trigger*.

Remote control

```
CONFigure:TRIGger:DEFault ON | OFF
```

Trigger The *Trigger* field determines how the measurement is to be triggered:

Free Run	Free-run mode, the measurement is carried out continuously, it is not related to the input signal,
RF Power	The measurement is triggered by the level of the RF signal to be measured,
IF Power	The measurement is triggered by the level of the IF signal,
Extern	External trigger signal fed in via connector AUX3 (pin no. 8).

For the *RF Power* and *IF Power* parameters the trigger level is specified via the *Level* command. *RF Power* trigger signals have a small dynamic range which is often not sufficient for triggering. It is recommended to trigger by the *IF Power* instead.

Note: *If no measurement result can be obtained the trigger mode may not fit to the trigger signal applied. Check the trigger mode and signal.*

Remote control

```
TRIGger[:SEQuence]:SOURce
                          IMMediate | RFPower | IFPower | EXTern
```

Level The *Trigger Level* field determines the trigger threshold if the measurement is triggered by the *RF Power* or *IF Power*.

The trigger threshold is the level at which the trigger signal starts triggering. With free-run measurements the *Trigger Level* field is disabled.

Low	low trigger level equal to the reference level – 26 dB
Medium	medium trigger level equal to the reference level – 16 dB
High	high trigger level equal to the reference level – 6 dB

Remote control

```
TRIGger[:SEQuence]:THReshold LOW | MEDium | HIGH
```

Slope

The *Slope* field determines whether the measurement is triggered by the rising or falling edge of the trigger signal. With free-run measurements or external trigger the *Slope* field is disabled.

Remote control
`TRIGger[:SEQuence]:SLOPe  POSitive | NEGative`

Options and Extensions

The function groups described in this section require the installation of hardware options; for a complete list of deliverable options refer to the data sheet. Software options for digital and analog network tests are described in separate operating manuals; for a list refer to the *Manuals* section before tabbed divider no. 1 of this manual.

Audio Generator and Analyzer (Option CMU-B41)

Option CMU-B41, *Audio Generator and Analyzer*, provides an additional *Audio* function group comprising the functions for generating and measuring audio signals. It can be accessed either from the *Menu Select* menu (standalone audio measurements) or by switching over from any of the *GSM900/1800/1900-MS* measurement menus (either in *Non Signalling* or *Signalling* mode). In the latter case, the audio circuit of a GSM mobile station can be tested without releasing a call connection or changing the signalling state of the CMU.

Standalone *audio* measurements are performed with default connector settings, the audio signals being applied to the connectors *AF IN* (input) and *AF OUT* (output) on the front panel of the instrument (see chapter 1). If *Audio* is used in the context of *GSM900/1800/1900-MS* measurements, the *AF/RF* ↔ tab of the associated *Connect. Control* menu allows to select the input source of the CMU speech encoder and the output destination of its speech decoder (see *GSM900/1800/1900-MS* operating manual).

Note: *In addition to the features reported in this section, option CMU-B41 offers some extended functionality that is accessible via remote control only:*

- Secondary audio circuit; analogous to the primary circuit
- Variable band pass filter
- Frequency counter

For a description of the additional features refer to chapter 6 in this manual.

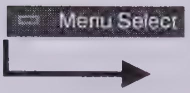
Measurement Menu Analyzer/Generator

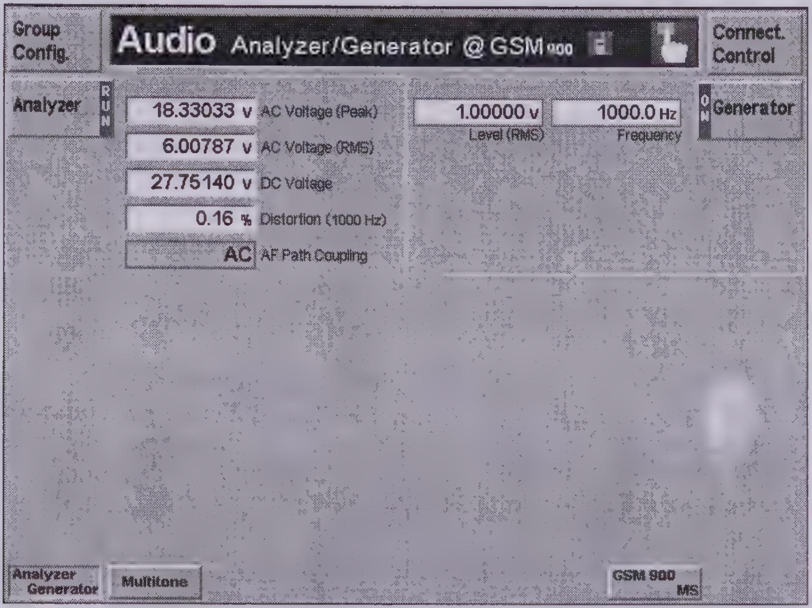
The main menu *Analyzer/Generator* defines the sinusoidal signal generated by the audio generator and displays the voltage of the measured audio signal.

The *Analyzer/Generator* menu is opened from the main menu *Menu Select* (with associated key at front of instrument) or via the *Audio* hotkey which is available in all *GSM400/900/1800/1900-MS* measurement menus. Compared to the standalone case, the latter option offers an extended functionality (see Fig. 4-28 below):

- The *Group Config.* and *Connect. Control* softkeys from the previous (calling) GSM function group are also available in *Audio*. The corresponding menus are described in the *GSM900/1800/1900-MS* operating manual, stock no. 1115.6088.12).
- A symbol indicating the GSM test mode is displayed in the menu header.
- A hotkey switching back to the GSM function group shows at the bottom of the menu.

The actual *Audio* functionality is identical in the standalone and GSM modes.





18.33033 V AC Voltage (Peak)
6.00787 V AC Voltage (RMS)
27.75140 V DC Voltage
0.16 % Distortion (1000 Hz)
AC AF Path Coupling
1.00000 V Level (RMS)
1000.0 Hz Frequency

Fig. 4-28 Measurement menu Analyzer/Generator (Audio)

Analyzer

The Analyzer softkey controls the audio measurement (RUN / HLT / OFF) and indicates its status. The measurement status can be changed by means of the *ON/OFF* key or the *CONT/HALT* key while the softkey is selected (press once). While the measurement is running, the measurement results are indicated and continuously updated in several output fields:

AC Voltage (Peak)	Peak value of the AC component of the measured AF signal in V.
AC Voltage (RMS)	Effective (RMS-averaged) value of the AC component of the measured AF signal in V.
DC Voltage	DC component of the measured AF signal in V
Distortion (xxx Hz)	Ratio of the measured AF signal with a notched-out reference frequency to the complete measured AF signal in percent. The reference frequency of the distortion measurement set in the *Distortion* tab of the configuration menu (see p. 4.53) is indicated in brackets. If the reference frequency is equal to the fundamental frequency of the AF signal, the *Distortion* value corresponds to the Total Harmonic Distortion and Noise. To avoid suppression of the first harmonic, the bandwidth of the notch filter is automatically adjusted to be smaller than the reference frequency.
AF Path Coupling	AF path coupling for combined AC/DC measurement *(DC)* or AC measurement *(AC)*, set in the *Control* tab of the configuration menu (see p. 4.51).

Measurement configuration

By pressing the selected *Analyzer* softkey for a second time the *Analyzer Configuration* popup-menu is opened; see p. 4.51.

Remote control

```
INITiate:AFANalyzer[:PRIMary]
STOP:AFANalyzer[:PRIMary]
ABORt:AFANalyzer[:PRIMary]
CONTinue:AFANalyzer[:PRIMary]
```

```
FETCh:AFANalyzer[:PRIMary]:STATus?

READ[:SCALar]:AFANalyzer[:PRIMary][:RESult]?
FETCh[:SCALar]:AFANalyzer[:PRIMary][:RESult]?
SAMPle[:SCALar]:AFANalyzer[:PRIMary][:RESult]?
```

Generator

The Generator softkey controls the audio generator (ON / OFF) and indicates its status. The generator can be switched on or off by means of the *ON/OFF* key while the softkey is selected (press once). The parameters determining the generated sinusoidal audio signal can be set in two input fields:

Level (RMS)	Effective (RMS averaged) voltage of the AF signal
Frequency	Frequency of the AF signal

Remote control

```
INITiate:AFGenerator[:PRIMary]
ABORt:AFGenerator[:PRIMary]

FETCh:AFGenerator[:PRIMary]:STATus?

SOURce:AFGenerator[:PRIMary]:LEVel <Level>
SOURce:AFGenerator[:PRIMary]:FREQuency <Frequency>
```

GSM 900 –MS Sign.

The hotkey switches back to the previous GSM function group.

This hotkey is available if the *Analyzer/Generator* menu is opened from a GSM function group. The hotkey is labeled with the calling function group and test mode, which is also displayed in the menu header.

Remote control

```
[SENSe:]POWer:FREQuency:CENTer <Frequency>
```

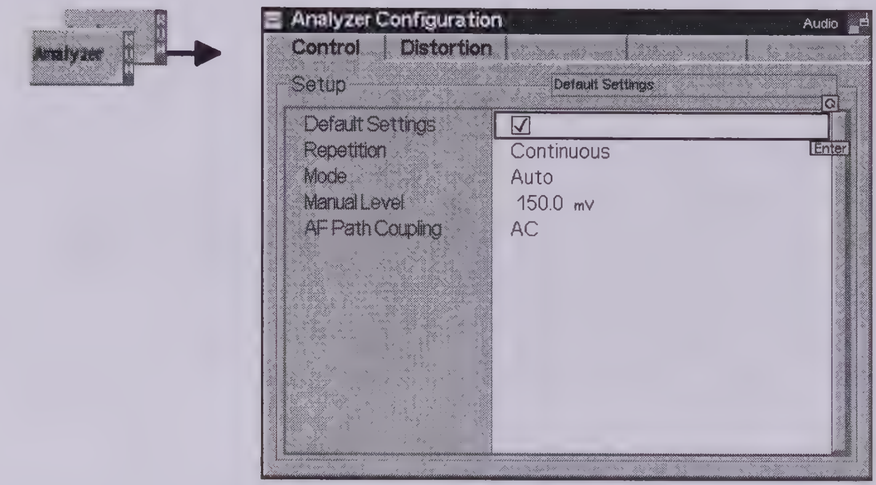
Measurement Configurations (Analyzer Configuration)

The popup menu *Analyzer Configuration* contains two tabs that determine the parameters of the *Audio* measurement. It is opened by pressing the softkey *Analyzer* in the measurement menu *Analyzer/Generator* twice. It is possible to change between the tabs by pressing the associated hotkeys.

Measurement Control (Analyzer Configuration – Control)

The *Control* tab determines:

- The *Repetition* mode,
- The maximum AF input level *(Mode, Manual Level)*,
- The *AF Path Coupling* of the audio measurement.



Default Settings	☑
Repetition	Continuous
Mode	Auto
Manual Level	150.0 mV
AF Path Coupling	AC

Fig. 4-29 Analyzer Configuration – Control

Default Settings

The *Default* switch assigns default values to all settings in the *Control* tab (the default values are quoted in the command description in chapter 6 of this manual).

Remote Control
–

Repetition

The *Repetition* field determines the repetition mode, see chapter 3 and explanations given on page 4.31 for the *Power versus Time* measurement. In *Audio,* one statistics cycle is terminated when the system has settled and a valid result is available.

Remote control
```
CONFigure:AFANalyzer[:PRIMary]:REPetition
        CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Mode / Manual Level

The *Mode* and *Manual Level* table rows are used to set the maximum expected AF input level. Levels exceeding this value can not be measured.

Manual	Manual input of maximum input level, to be entered in the *Manual Level* table row (in mV).
Auto	Automatic setting of maximum input level *(autoranging)* according to average power of applied AF signal (plus an appropriate overload margin).

Note: *A maximum input level can be entered even if automatic level setting (autoranging) is selected. It serves as a start value for the autoranging algorithm and is important to ensure safe switchover to manual setting.*

Error messages

If the value set for *Manual Level* is too high or too low, a window with the error message *"<Max_Level> is out of range. <permissible max. value> is limit."* and three fields will appear:

Accept	The permissible max. value is accepted as maximum input level.
Re-edit	The *Manual Level* is entered once again.
Cancel	The last valid input value is maintained.

Remote control
```
[SENSe:]AFLEVel:MODE <Mode>
[SENSe:]AFLEVel:MAXimum <Level>
```

AF Path Coupling The *AF Path Coupling* field sets the input path for measurement of the AC or AC and DC component of the AF signal:

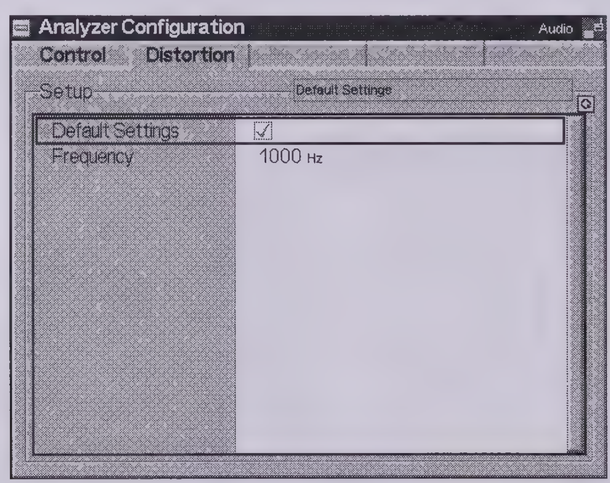
AC	DC component of the measured AF signal (including a possible DC offset of the input amplifier) blocked. This ensures accurate measurement of the AC component. The DC component, however, can not be measured; the *DC Voltage* output field in the *Analyzer/Generator* menu indicates "---".
DC	Measurement of the complete AF input signal (DC plus AC components).

Remote control

```
CONFigure:AFANalyzer[:PRIMary]CONTrol:COUPling  AC | DC
```

Measurement Control (Analyzer Configuration – Distortion)

The *Control* tab determines the reference frequency of the distortion measurement.



Default Settings	☑
Frequency	1000 Hz

Fig. 4-30 Analyzer Configuration – Control

Default Settings The *Default Settings* switch assigns default values to all settings in the *Distortion* tab (the default values are quoted in the command description in chapter 6 of this manual).

Remote Control

–

Frequency The *Frequency* field defines the reference frequency of the distortion measurement. If the reference frequency is set to the fundamental frequency of the AF signal, the *Distortion* value corresponds to the Total Harmonic Distortion and Noise.

Remote control

```
CONFigure:SPECtrum:CONTrol:REPetition
      CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Measurement Menu Multitone

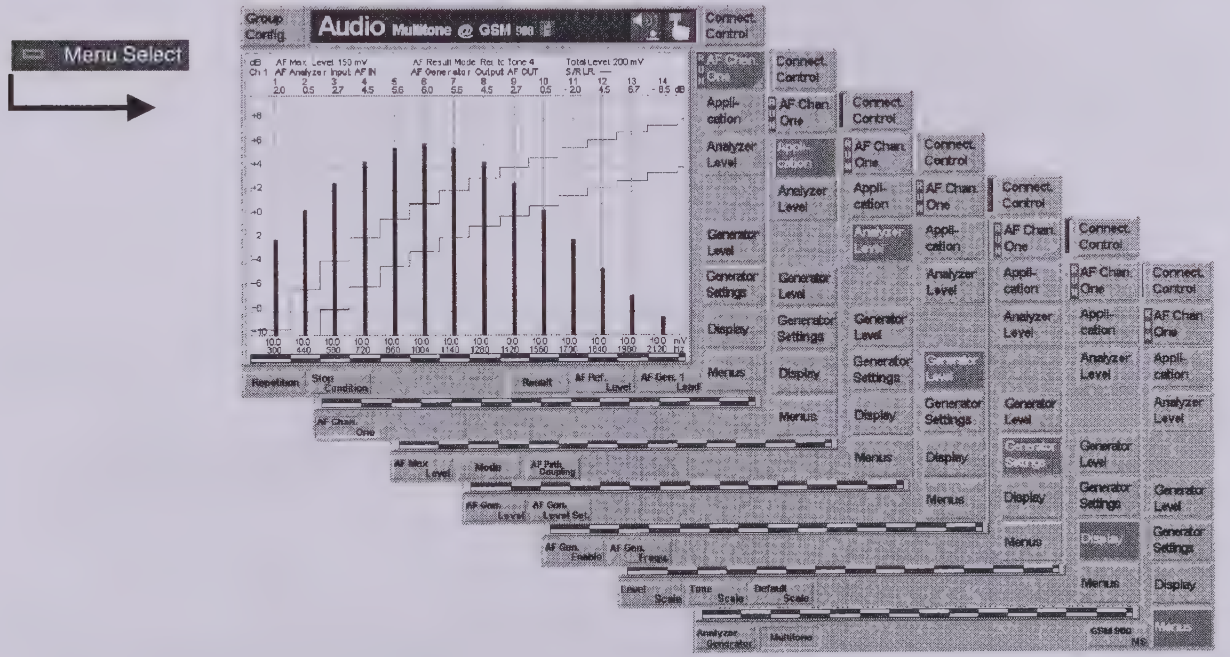
The graphical measurement menu *Multitone* shows the results of the multitone audio measurement.

To perform an *Multitone* measurement, the CMU generates a composite audio signal that represents the superposition of up to 20 individual fixed-frequency tones with configurable frequency and level. An audio signal containing the same tones can be analyzed in a single measurement and displayed in a bar chart.

The *Multitone* measurement is thus a fast method to determine the level of up to 20 different tones at known frequencies and to perform a limit check for all results. Possible applications are also frequency response and intermodulation measurments.

- The main softkey *Multitone* controls the *Multitone* measurement, indicates its status *(RUN | HLT | OFF)* and opens the configuration menu *Multitone Configuration* (press twice). The hotkeys associated to the main softkey define the scope of the *Multitone* measurement.
- The other softkeys to the right of the test diagram are combined with various hotkeys (e.g. the hotkeys *AF Max. Level, Mode,* and *AF Path Coupling* belong to the softkey *Analyzer Level).* If a softkey is selected and an associated hotkey is pressed, a popup window will appear which indicates the current setting and enables an entry (for an example, see section *Test settings* on page 4.24 ff.).

The measurement menu *Multitone* is opened via the main menu *Menu Select* (with the associated key at the front of the instrument) or from the *Analyzer/Generator* menu using the *Multitone* hotkey.



AF Max. Level 150 mV
AF Analyzer Input AF IN
AF Result Mode Rel. to Tone 4
AF Generator Output AF OUT
Total Level 200 mV
S/R LR —

Menu Select
Group Config
Audio Multitone @ GSM 900
Connect. Control
dB
Ch 1
1 2 3 4 5 6 7 8 9 10 11 12 13 14
2.0 0.5 2.7 4.5 5.6 6.0 5.6 4.5 2.7 0.5 -2.0 4.5 6.7 -8.5 dB
+8 +6 +4 +2 +0 2 -4 -6 -8 -10
10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 0.0 10.0 10.0 10.0 10.0 10.0 mV
300 440 580 720 860 1004 1140 1280 1120 1560 1700 1840 1980 2120 Hz
AF Chan. One
Appli-cation
Analyzer Level
Generator Level
Generator Settings
Display
Menus
Repetition
Stop Condition
Restart
AF Ref. Level
AF Gen. 1 Level
AF Chan. One
AF Max. Level
Mode
AF Path Coupling
AF Gen. Level
AF Gen. Level Set
AF Gen. Enable
AF Gen. Freqs
Level Scale
Tone Scale
Default Scale
Analyzer Generator
Multitone
GSM 900 MS

Fig. 4-1 Measurement menu Multitone

Test Settings

The *Multitone* measurement can be configured by means of the softkeys and hotkeys in the graphical measurement menu.

AF Chan. One

The *AF Chan. One* softkey controls the *Multitone* measurement and indicates its status *(RUN | HLT | OFF).*

This status can be changed after softkey selection (pressing once) by means of the *ON/OFF* key or the *CONT/HALT* key.

Remote control

```
INITiate:MULTitone:AF1Channel; ABORt:MULTitone:AF1Channel;
STOP:MULTitone:AF1Channel; CONTINUE:MULTitone:AF1Channel
FETCh:MULTitone:AF1Channel:STATus?
```

Measurement configuration

Pressing the *AF Chan. One* softkey twice opens the popup menus *Multitone Configuration* (see page 4.60). Besides, the following hotkeys defining the scope of the measurement are associated to the *Power versus Time* softkey:

Repetition

The hotkey *Repetition* determines the repetition mode of the measurement *(Single Shot* or *Continuous* measurement); see chapter 3 and explanations given on page 4.31 for the *Power versus Time* measurement. In *Audio,* one statistics cycle is terminated when the system has settled and a valid result is available.

Remote control

```
CONFigure::MULTitone:AF1Channel:CONTrol:REPetition
      <Repetition>,<StopCond>,<Stepmode>
```

Stop Condition

The *Stop Condition* hotkey sets a stop condition for the measurement:

NONE	Continue measurement irrespective of the results of the limit check.
On Limit Failure	Stop measurement as soon as the limit check fails (one of the tolerances is exceeded).

Remote control

```
CONFigure:MULTitone:AF1Channel:CONTrol:REPetition
             <Repetition>,<StopCond>,<Stepmode>
```

Result

The *Result* hotkey defines the reference value for all measurement results. This corresponds to the 0 dB reference line in the diagram.

Relative to AF Ref. Lev. [dB]	All results are referenced to the *AF Ref. Level*; see below
Relative to Tone 1 [dB]	All results are referenced to the measurement result at tone 1 (if available)
...	
Relative to Tone 20 [dB]	All results are referenced to the measurement result at tone 20 (if available)

The measurement is taken at up to 20 audio frequencies (tone 1 to 20) which can be defined and switched on or off in the *Tone Def.* tab of the configuration menu (see page 4.63 ff.).

Remote control

```
CONFigure::MULTitone:AF1Channel:RMODe  RLEV | TON<nr>
```

AF Ref. Level

The *AF Ref. Level* hotkey defines an audio reference level. The reference level is entered as an RMS voltage (in mV) and defines the 0 dB line of the test diagram provided that this is selected as an option via the *Result* hotkey (see above).

Remote control

```
CONFigure:MULTitone:AF1Channel:RLEVel <Voltage>
```

AF Gen. 1 Lead

The *AF Generator Lead* hotkey defines a settling time for the measurement to be applied after a change of the generator settings. A small value accelerates the measurement but may impair its accuracy.

Remote control
`CONFigure:MULTitone:AF1Channel:AFGLead <Time>`

Application

The *Application* softkey activates one of the applications of the *Multitone* measurement. At present, only one application – *AF Chan. One* – is available.

AF Chan. One

The *AF Chan. One* hotkey selects the *Multitone* measurement on channel one. This means that the audio signals are applied to the connectors AF IN (CMU input) and AF OUT (CMU output) on the front panel. A second audio channel is available in remote control.

Remote control
Audio channel no. one is identified by the third-level keyword `AF1Channel`. The second audio channel is identified by `AF2Channel`.

Analyzer Level

The *Analyzer Level* softkey controls the level in the AF input signal path for all applications within the *Multitone* measurement.

AF Max. Level

The *AF Max. Level* hotkey sets the maximum expected input level in mV. The setting is applied if the *AF Mode* (see softkey below) is set to *Manual.*

Remote control
`[SENSE:]AFLevel:MAXimum <Level>`

Mode

The *Mode* hotkey determines how the input level is defined.

Manual	Manual input via *AF Max. Level* hotkey
Auto	Automatic setting according to the average power of the applied AF signal.

Remote control
`[SENSE:]AFLevel:MODE  MANual | AUTOmatic`

AF Path Coupling

The *AF Path Coupling* hotkey sets the input path for the AC component or for the AC plus DC *components of the input signal. The setting is analogous to the* AF Path Coupling set in the *Control* tab of the *Analyzer Configuration* menu; see section *Measurement Control (Analyzer Configuration – Control)* on page 4.51.

Remote control
`CONFigure:AFANalyzer[:PRIMary]:CONTrol:COUPling AC | DC`

Generator Level

The *Generator Level* softkey defines the level of the AF multitone signal.

The generator level settings are described in more detail in section *Test Tones (Multitone Configuration – Tone Def.)* on page 4.63 ff.

AF Gen. Level

The *AF Gen. Level* hotkey defines the absolute AF generator level in mV. The function of this hotkey depends on the setting of the *AF Gen. Level Set.* hotkey described below:

- If *AF Gen. Level Set.* is set to *Use Separate Levels,* a separate AF level (in mV) can be assigned to each of the 20 test tones.
- If *AF Gen. Level Set.* is set to *Use Total Level,* a single sum level (also in mV) is defined for the whole multitone signal. This level is evenly distributed among all enabled test tones.

Remote control
```
CONFigure:MULTitone:AF1Channel:TDEFinition
CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>
or CONFigure:MULTitone:AF1Channel:TDEFinition:TLEVel
```

AF Gen. Level Set.

The *AF Gen. Level Set.* hotkey defines how the level of each of the test tones is determined:

Use Separate Levels	A separate AF level (in mV) can be assigned to each of the 20 test tones.
Use Total Level	A single sum level (also in mV) is defined for the whole multitone signal. This level is evenly distributed among all test tones defined and enabled in the *Tone Def.* tab of the configuration menu (see section *Test Tones (Multitone Configuration – Tone Def.)* on page 4.63 ff). If a test tone is disabled, the total level is maintained and the share of the remaining test tones in the total level increases.

The levels are entered via *AF Gen. Level*, see above.

Remote control
```
CONFigure:MULTitone:AF1Channel:TDEFinition:MODE
      SEParate | TLEVel
```

Generator Settings

The *Generator Settings* softkey configures the AF signal generated.

The generator settings are described in more detail in section *Test Tones (Multitone Configuration – Tone Def.)* on page 4.63 ff.

AF Gen. Enable

The *AF Gen. Enable* hotkey switches the individual tones in the audio signal and the corresponding bar in the test diagram on (box checked) or off.

Remote control
```
CONFigure:MULTitone:AF1Channel:TDEFinition
CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>
```

AF Gen. Freq.

The *AF Gen. Freq.* hotkey assigns an audio frequency (in Hz) to each of the 20 test tones.

Remote control
```
CONFigure:MULTitone:AF1Channel:TDEFinition
CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>
```

Display

The *Display* softkey scales or shifts the graphical display.

Level Scale

The *Level Scale* hotkey defines the level scale of the *Multitone* test diagram (ordinate scale). The level scale merely represents a display configuration that doesn't have any impact on the measurement or on the input signal path.

The level scale is calculated from a maximum value *(Max.)* and a *Span:*

- The *Max* value defines the upper edge of the diagram.
- The difference *Max – Span* defines the lower edge of the diagram.
- The number of horizontal grid lines (corresponding to 10, 15, or 16 cells) and the ordinate labeling is adapted to the range.

Remote control
no remote control command; screen configuration only

Tone Scale

The *Tone Scale* hotkey selects the display range (abscissa scale) of the test diagram. The range comprises 14 test tones which must be in consecutive order. This condition leaves the following options:

Tone 1 to 14	Display all results between tone 1 and tone 14
...	
Tone 7 to 20	Display all results between tone 7 and tone 20

If a tone is within the selected range but disabled in the *Tone Def.* tab of the configuration menu (see section *Test Tones (Multitone Configuration – Tone Def.)* on page 4.63 ff.), the corresponding result is not indicated, i.e. the bar is omitted and a gap occurs in the test diagram.

Remote control
no remote control command; screen configuration only

Default Scale

The *Default Scale* hotkey cancels all display configurations made and activates the default settings.

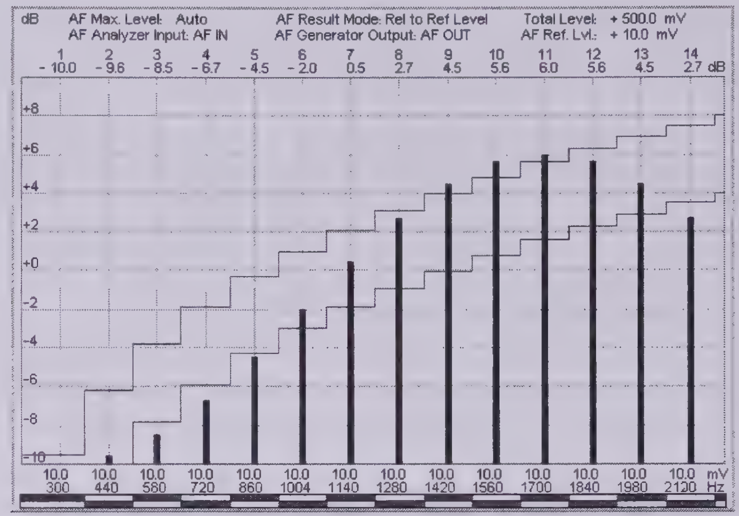
Remote control
no remote control command; screen configuration only

Menus

The *Menus* softkey displays the hotkey bar for switching over to the other measurement menus.

Measurement Results

The *Multitone* measurement menu displays the individual levels at up to 14 out of 20 different test tones, corresponding to 20 (not necessarily distinct) audio input frequencies. The results and the test settings are indicated in two parameter lines and the actual test diagram (bar graph) with its axis labels:



AF Max. Level: Auto
AF Result Mode: Rel to Ref Level
Total Level: + 500.0 mV
AF Analyzer Input: AF IN
AF Generator Output: AF OUT
AF Ref. Lvl.: + 10.0 mV

dB
1 2 3 4 5 6 7 8 9 10 11 12 13 14
- 10.0 - 9.6 - 8.5 - 6.7 - 4.5 - 2.0 0.5 2.7 4.5 5.6 6.0 5.6 4.5 2.7 dB
+8
+6
+4
+2
+0
-2
-4
-6
-8
-10
10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 mV
300 440 580 720 860 1004 1140 1280 1420 1560 1700 1840 1980 2120 Hz

Parameter lines

Test tone no. and frequency response

Bar graph with upper and lower limit lines

Test tone voltage and frequency

Fig. 4-2 Display of measurement results (Multitone)

Parameter lines The first parameter line contains the following settings and results:

AF Max. Level	Maximum AF input level in mV as set by means of the *AF Max. Level* softkey described on p. 4.56.
AF Result Mode	Reference value for all levels as set via the *Result* hotkey described on p. 4.55
Total Level	Sum of the individual levels of all test tones measured in mV.

The second parameter line contains the following settings:

AF Analyzer Input	Input connector used for the *Multitone* measurement. In the *AF Chan. One* application, AF IN is used.
AF Generator Output	Output connector used for the *Multitone* measurement. In the *AF Chan. One* application, AF OUT is used.
AF Ref. Lvl	0-dB line in the test diagram as defined via the *AF Ref. Level* hotkey described on p. 4.55.

Remote control
The settings are read out using the query corresponding to the setting command (setting command with appended question mark).

Bar graph The bar graph shows the AF level in dB at a maximum of 14 out of 20 different audio frequencies corresponding to a continuous range of test tones configured in the *Tone Def.* tab of the configuration menu (see p. 4.63 ff.). If a test tone is disabled in the configuration menu, the corresponding bar is omitted.

Frequency axis (abscissa) The range of test tones (no. 1 to 14, 2 to 15 etc.) to be viewed can be selected via the *Frequency* softkey. The bars representing the level of the different tones are equidistantly distributed over the whole diagram width. This optimizes the readability of the diagram but implies that the abscissa scale is not necessarily linear. Therefore, the frequency and voltage of every single test tone is displayed below the frequency axis.

Frequency response axis (ordinate) The ordinate can be arbitrarily scaled by setting a maximum and minimum value (both in dB). With a fixed ordinate, the adjustable 0 dB reference line (see *AF Ref. Level* hotkey described on p. 4.55) allows to shift the whole diagram vertically.

Remote control
`READ:ARRay:MULTitone:AF1Channel?` etc.
`READ[:SCALar]:MULTitone:AF1Channel:TONE<nr>?` etc.

Limit Check

The upper and lower limit lines for each test point defined in the *Limit Lines* tab of the configuration menu (see p. 4.62) correspond to the two red step functions in the diagram. If the limit check fails at a particular test point, the corresponding section of the red bar across the bottom of the diagram is shifted upwards.

Remote control
```
CALCulate:ARRay:MULTitone:AF1Channel:MATChing:LIMit?
CALCulate[:SCALar]:MULTitone:AF1Channel:TONE<nr>:MATChing:
      LIMit?
CALCulate[:SCALar]:MULTitone:AF1Channel:MATChing:LIMit?
```

Measurement Configurations (Multitone Configuration)

The popup menu *Multitone Configuration* contains four tabs which determine the parameters of the *Multitone* measurement including the error tolerances.

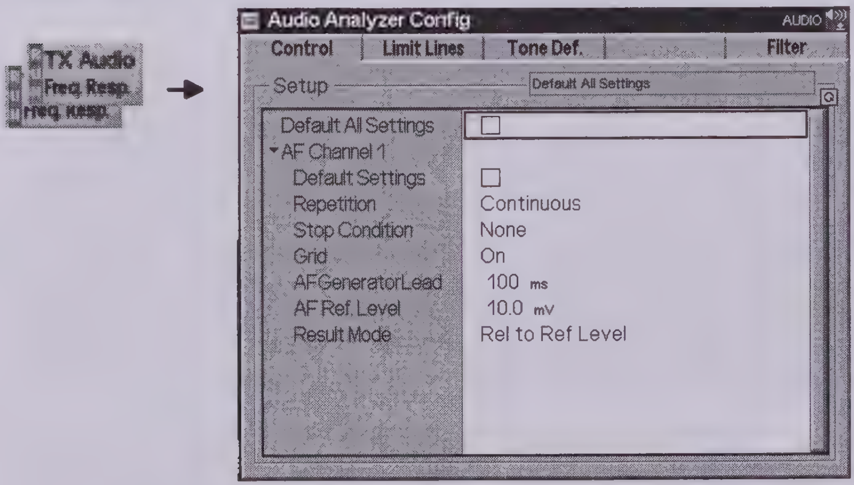
The popup menu *Multitone Configuration* is activated by pressing the main softkey *AF Chan. One* in the measurement menu *Multitone* twice. It is possible to change between the tabs by pressing the associated hotkeys.

Measurement Control (Multitone Configuration – Control)

The *Control* tab controls the *Multitone* measurement by determining

- The *Repetition* mode
- The *Stop Condition* for the measurement
- A settling time for the AF generator *(AF Generator Lead)*
- The 0-dB line in the graphical diagram *(AF Ref. Level)*
- Reference value for all levels in the graphical diagram *(Result Mode)*

Besides, it configures the measurement diagram by adding or removing the *Grid*.



Default All Settings ☐
AF Channel 1
Default Settings ☐
Repetition Continuous
Stop Condition None
Grid On
AFGeneratorLead 100 ms
AF Ref. Level 10.0 mV
Result Mode Rel to Ref Level

Fig. 4-3 Multitone Configuration – Control

Default Settings The *Default* switch assigns default values to all settings in the *Control* tab (the default values are quoted in the command description in chapter 6 of this manual). A second default switch (which is equivalent to the first one) resets all *AF Channel 1* settings.

Remote Control
```
CONFigure:MULTitone:AF1Channel:REPetition DEF, DEF, DEF
```

Repetition The *Repetition* field determines the repetition mode, see chapter 3 and explanations given on page 4.31 for the *Power versus Time* measurement. In *Audio,* one statistics cycle is terminated when the system has settled and a valid result is available.

Remote control
```
CONFigure:MULTitone:AF1Channel:REPetition
        CONTinuous | SINGleshot | 1 ... 10000,NONE,<Stepmode>
```

Stop Condition The *Stop Condition* table row defines a stop condition for the measurement:

None	Continue measurement even if tolerance is exceeded
On Limit Failure	Stop measurement if tolerance is exceeded

Remote control
```
CONFigure:TXTests:<Applic>:CONTrol:REPetition
           <REPetition>,SONerror | NONE,<Stepmode>
```
where `<Applic> = MODulation | HNOise | AFLSearch`

AF Generator Lead The *AF Generator Lead* table row defines a settling time for the measurement to be applied after a change of the generator settings. A small value accelerates the measurement but may impair its accuracy.

Remote control
```
CONFigure:MULTitone:AF1Channel:AFGLead <Time>
```

AF Ref. Level The *AF Ref. Level* table row defines an audio reference level. The reference level is entered as an RMS voltage (in mV) and defines the 0 dB line of the test diagram provided that *Relative to Ref. Lev.* is selected as *Result Mode* (see below).

Remote control
```
CONFigure:MULTitone:AF1Channel:RLEVel <Voltage>
```

Result Mode The *ResultMode* table row defines the reference value for all measurement results. This corresponds to the 0 dB reference line in the diagram.

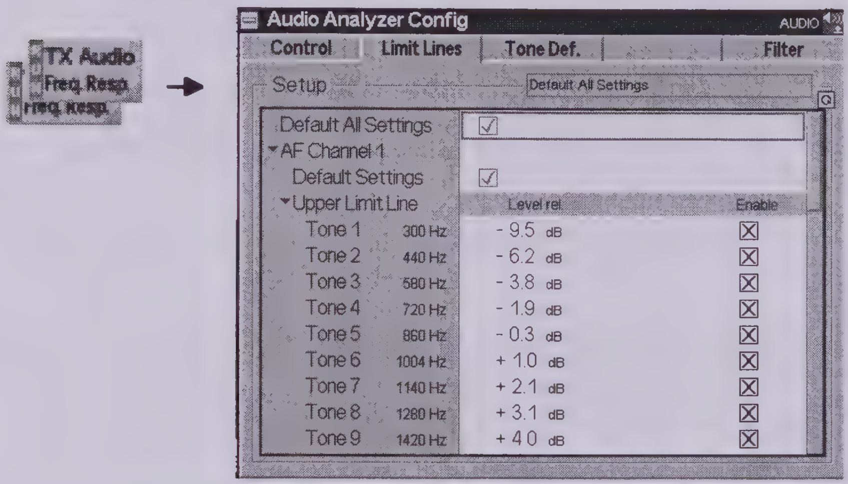
Relative to Ref. Lev.	All results are referenced to the AF Ref. Level; see above
Relative to Tone 1	All results are referenced to the measurement result at tone 1 (if available)
...	
Relative to Tone 20	All results are referenced to the measurement result at tone 20 (if available)

The measurement is taken at up to 20 audio frequencies (tone 1 to 20) which can be defined and switched on or off in the *Tone Def.* tab of the configuration menu (see page 4.63 ff.).

Remote control
```
CONFigure::MULTitone:AF1Channel:RMODe  RLEV | TON<nr>
```

Limit Lines (Multitone Configuration – Limit Lines)

The *Limit Lines* tab defines upper and lower limits for the audio level at all test tones and enables or disables the limit check.



Default All Settings ☑

AF Channel 1

Default Settings ☑

Upper Limit Line

		Level rel.	Enable
Tone 1	300 Hz	- 9.5 dB	☒
Tone 2	440 Hz	- 6.2 dB	☒
Tone 3	580 Hz	- 3.8 dB	☒
Tone 4	720 Hz	- 1.9 dB	☒
Tone 5	860 Hz	- 0.3 dB	☒
Tone 6	1004 Hz	+ 1.0 dB	☒
Tone 7	1140 Hz	+ 2.1 dB	☒
Tone 8	1280 Hz	+ 3.1 dB	☒
Tone 9	1420 Hz	+ 4.0 dB	☒

Fig. 4-4 Multitone Configuration – Limit Lines

Default Settings The *Default All Settings* switch assigns default values to all fields in the *Limit Lines* tab (the default values are quoted in the command description in chapter 6 of this manual). A second default switch (which is equivalent to the first one) resets all *AF Channel 1* settings.

Remote control

```
DEFault:MULTitone:LIMit:LINE  ON | OFF
DEFault:MULTitone:AF1Channel:LIMit:LINE  ON | OFF
```

Upper Limit Line/ Lower Limit Line Upper and lower limit lines for all 20 test points can be defined separately in the two table sections *Upper Limit Line* and *Lower Limit Line.*

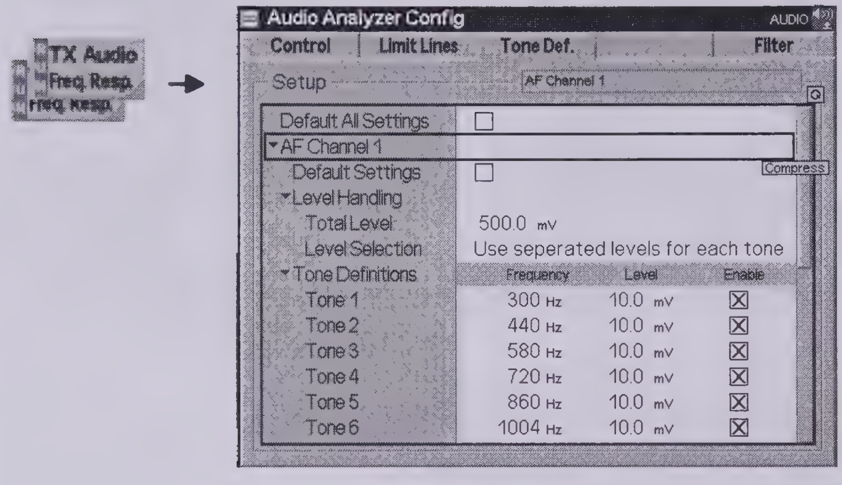
The tone nos. and the corresponding frequencies are indicated in the two left columns of the table as defined in the *Tone Def.* tab (see p. 4.63). For each tone, the upper and lower limit can be entered as a single value in dB. The corresponding *Enable* checkbox switches the limit line in the test diagram and the limit check on (if checked) or off.

Remote control

```
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:UPPer
      <Limit_1>, <Enable_1>...
CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE
         :ASYMmetric:UPPer <Limit>, <Enable>
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:LOWer
         <Limit_1>, <Enable_1>...
CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE
         :ASYMmetric:LOWer <Limit>, <Enable>
```

Test Tones (Multitone Configuration – Tone Def.)

The *Tone Def.* tab configures the audio test signal generated by the CMU. This signal is composed of up to 20 test tones with different frequencies and levels.



Setup: AF Channel 1

Default All Settings ☐

AF Channel 1

Default Settings ☐

Level Handling

Total Level 500.0 mV

Level Selection Use seperated levels for each tone

Tone Definitions

Tone Definitions	Frequency	Level	Enable
Tone 1	300 Hz	10.0 mV	☒
Tone 2	440 Hz	10.0 mV	☒
Tone 3	580 Hz	10.0 mV	☒
Tone 4	720 Hz	10.0 mV	☒
Tone 5	860 Hz	10.0 mV	☒
Tone 6	1004 Hz	10.0 mV	☒

Fig. 4-5 Multitone Configuration – Tone Def.

Default Settings The *Default All Settings* switch assigns default values to all fields in the *Tone Def.* tab (the default values are quoted in the command description in chapter 6 of this manual). A second default switch (which is equivalent to the first one) resets all *AF Channel 1* settings.

Remote control

```
DEFault:MULTitone:FILTer  ON | OFF
DEFault:MULTitone:AF1Channel:FILTer  ON | OFF
```

Level Handling: Total Level The *Total Level* parameter defines the sum of the individual voltages of all enabled tones. The meaning of the total level depends on the *Level Selection* setting, see below. The *Total Level* entered in the *Manual* column must not exceed the maximum level of the AF generator quoted in the data sheet.

Remote control

```
CONFigure:MULTitone:AF1Channel:TDEFinition:TLEVel
```

Level Selection The *Level Selection* table section defines how the voltage of each of the test tones is determined:

Use separate levels for each tone	The *Total Level* is ignored. It can still be edited for future measurements where the *Level Selection* parameter is set to *Manual*.
Use Total Level	The *Total Level* entered in the *Manual* column is evenly distributed among all test tones. This means that the level of each test tone enabled via the *AF Gen.* switch in the *Tone Definitions* table is set to *Total Level / n* where n is the number of test tones enabled (n = 1 to 20).

Remote control

```
CONFigure:MULTitone:AF1Channel:TDEFinition:MODE
          SEParate | TLEVel
```

Tone Definitions

The *Tone Definitions* table assigns an audio frequency (in Hz) and RMS voltage (in mV) to each of the 20 test tones.

The frequencies must be multiples of 1 Hz. It is possible, however, to define several tones at the same frequency, or to number the tones in arbitrary order: The x-axis is scaled by the **number** of the test tones, not by their frequency. The RMS voltages *(levels)* of different tones may coincide and can vary within the range quoted in the remote control command description in chapter 6 of this manual. The sum of all test tones must not exceed the maximum level of the AF generator quoted in the data sheet.

Note: *The voltages of all test tones enabled can be set manually or automatically, depending on the setting of the* Level Selection *parameter described above.*

The *AF Gen.* checkbox switches the tone in the audio signal and the corresponding bar in the test diagram on (if checked) or off.

Remote control

```
CONFigure:MULTitone:AF1Channel:TDEFinition
          <Freq_1>,<Level_1>,<Enable_1>,...
CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>
          <Freq>,<Level>,<Enable>,...
```

Path Configuration (TX Tests Configuration – Filter)

The *Filter* tab configures the receive path of the CMU for the *Multitone* measurement (see Fig. 4-6 below).

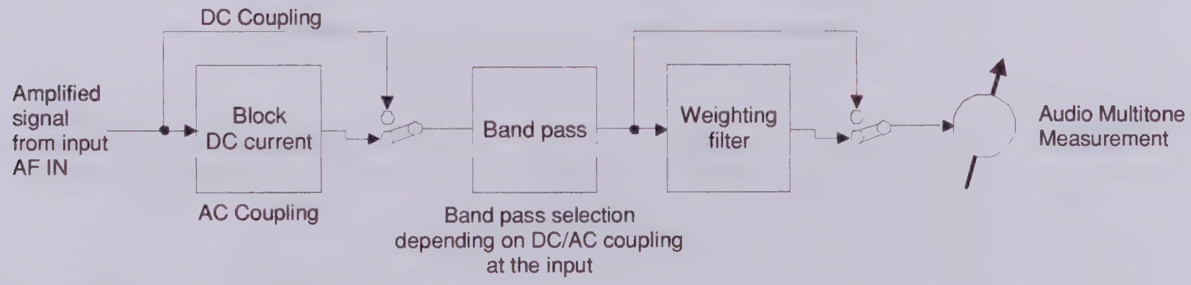
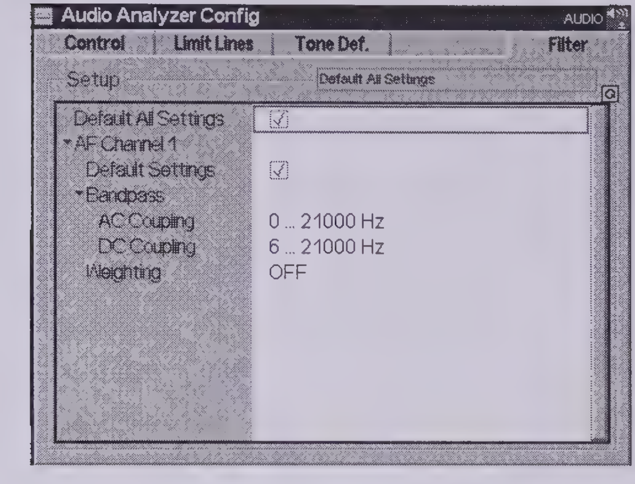

DC Coupling
Amplified signal from input AF IN
Block DC current
AC Coupling
Band pass
Band pass selection depending on DC/AC coupling at the input
Weighting filter
Audio Multitone Measurement

Fig. 4-6 Signal path for Multitone measurements

The audio receive path of the CMU may contain the following filter stages:

AF Path Coupling	Capacitor stage to block the DC component of the AF input signal including a possible DC offset of the input amplifier. With DC coupling, the complete AF input signal is measured.
Weighting	Weighting filter according to CCITT or C-message weighted filter.
Band Pass	Audio band pass filter with selectable bandwidth to limit the input frequencies to a definite audio band and eliminate unwanted signal components. The allowed bandwidth depends on the *AF Path Coupling*.

The audio results are generated at the end of the audio receive path, after the audio signal has passed all filter stages that are switched on.



Setup: Default All Settings

- Default All Settings ☑
- AF Channel 1
  - Default Settings ☑
  - Bandpass
    - AC Coupling 0 ... 21000 Hz
    - DC Coupling 6 ... 21000 Hz
  - Weighting OFF

Fig. 4-7 Multitone Configuration – Filter

Default All Settings

The *Default All Settings* switch assigns default values to all fields in the *Filter* tab (the default values are quoted in the command description in chapter 6 of this manual). A second default switch (which is equivalent to the first one) resets all *AF Channel 1* settings.

Remote control

```
DEFault:MULTitone:FILTer ON | OFF
DEFault:MULTitone:AF1Channel:FILTer ON | OFF
```

AF Channel 1

The table section *AF Channel 1* defines the input path for the *Multitone* measurement. The following settings are provided:

Band pass	Selection of the bandwidth of the CMU's audio band pass. A separate band pass can be selected for AC coupling and DC coupling.
Weighting	Use of a C-message weighted filter *(C-Message)*, a *CCITT* weighting filter or none of these filters *(OFF)*.

For a list of band pass frequency ranges provided refer to the remote control command description in chapter 6 of this manual.

Note: *If the* AF Path Coupling *is set to DC (see section* Measurement Control (Analyzer Configuration – Control) *on page 4.51), the audio analyzer receives the complete AF input signal including a possible DC component. To avoid measurement inaccuracies, a band pass with a lower cutoff ≥ 6 Hz must be used.*

Remote control

```
CONFigure:MULTitone:AF1Channel:FILTer:BPASs:DCCoupling
               <Bandwidth>
CONFigure:MULTitone:AF1Channel:FILTer:BPASs:ACCoupling
               <Bandwidth>
CONFigure:MULTitone:AF1Channel:FILTer:BPASs:WEIGhting
               CME | CCI | OFF
```

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5 Remote Control - Basics

In this chapter you find:

- instructions how to put the CMU into operation via remote control,
- a general introduction to remote control of programmable instruments. This includes the description of the command structure and syntax according to the SCPI standard, the description of command execution and of the status registers,
- diagrams and tables describing the status registers used in the CMU.

In section *Special Terms and Notation* on page 5.39, concepts and terms relating to remote control of CMU in particular are discussed. In same chapter 6, all *remote* control functions of the basic unit and of function group *RF Analyzer* are described in detail. For each group of measurements or configurations, all commands and their parameters are listed by alphabetical order in the command list at the end of chapter 6.

Program examples for the CMU can be found in chapter 7.

Introduction

The instrument is equipped with an GPIB bus interface according to standard IEC 625.1/IEEE 488.1. The connectors are located at the rear of the instrument and permit to connect a controller for remote control.

This section assumes basic knowledge of GPIB bus programming and operation of the controller. A description of the interface commands can be obtained from the relevant manuals.

Not all of the commands supported by the instrument are taken from the SCPI standard (Standard Commands for Programmable Instruments), however, their syntax follows SCPI rules. The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers (see section *SCPI Introduction*).

The requirements of the SCPI standard placed on command syntax, error handling and configuration of the status registers are explained in detail in the following sections. Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers.

Note: *In contrast to instruments with manual control, which are designed for maximum possible operating convenience, the priority of remote control is the "predictability" of the device status. This means that when incompatible settings are attempted, the command is ignored and the device status remains unchanged, i.e. other settings are not automatically adapted. Therefore, GPIB bus control programs should always define an initial device status (e.g. with the command *RST) and then implement the required settings.*

Operation via Remote Control

As any device, the CMU must be assigned a unique primary address in the range 0 to 30 decimal. In addition it uses extended addressing, i.e. a secondary address must be assigned to the individual function groups. Primary and secondary addresses can be defined in the *Remote* index card of the *Setup* menu (see chapter 4) or via remote control.

Switchover to Remote Control

On power-on, the instrument is always in the manual operating state and can be operated via the front panel controls. The instrument is switched to remote control in the following cases:

With active GPIB bus	as soon as the Remote Enable (REN) GPIB line is asserted by the controller.
With active RS-232 interface	as soon as the instrument receives any characters via the interface.

Operation via the front panel is disabled. The instrument remains in the remote state until it is reset to the manual state via the front panel or via GPIB bus (see section *Return to Manual Operation).* Switching from manual operation to remote control does not affect the device settings.

Setting the Device Address

The GPIB address (primary address) of the instrument is factory-set to 20. It can be changed manually via the *Primary Address* softkey in the *Setup - Remote* menu or via GPIB bus. For remote control, addresses 0 through 30 are permissible.

In addition to the primary address, up to 30 secondary addresses can be assigned to the individual function groups. The secondary address is set via the *Second. Address* softkey in the *Setup - Remote* menu or via remote control.

Note: *In the Setup – Remote menu, secondary addresses between 1 and 30 can be assigned. For reasons of compatibility with the National Instruments driver, the secondary addresses used for remote control must be in the range between 96 and 125 decimal.*

Changing the addresses manually:

- Call *Setup - Remote* menu.
- Press *Primary Address* softkey. Enter desired address in the input field.
- Press *Second. Address* softkey. Use the rotary knob to select the list line with the desired address (numbers 1 to 30). Press ENTER to edit the line. From the popup window select the desired function group (use the rotary knob to change between the entries in the popup window). Confirm your selection and close the popup window using the ENTER key.
- Press the *ESCAPE* key to close the *Setup – Remote* menu.

Via GPIB bus interface:

- Use the `SYSTem:REMote:ADDRess:PRIMary <Addr_1>` command to define the GPIB bus address of the CMU.
- Use the `SYSTem:REMote:ADDRess:SECondary <Addr_2>,"<Fgroup>"` command to assign distinct secondary addresses to all function groups needed. The secondary address is transferred with each command (physical/hardware addressing, see program example in chapter 7). Alternatively, software switchover with a command preceded by a secondary address and a semicolon is possible:

  `<Addr_2>;<Command>` (logical addressing of secondary address; use semicolon)

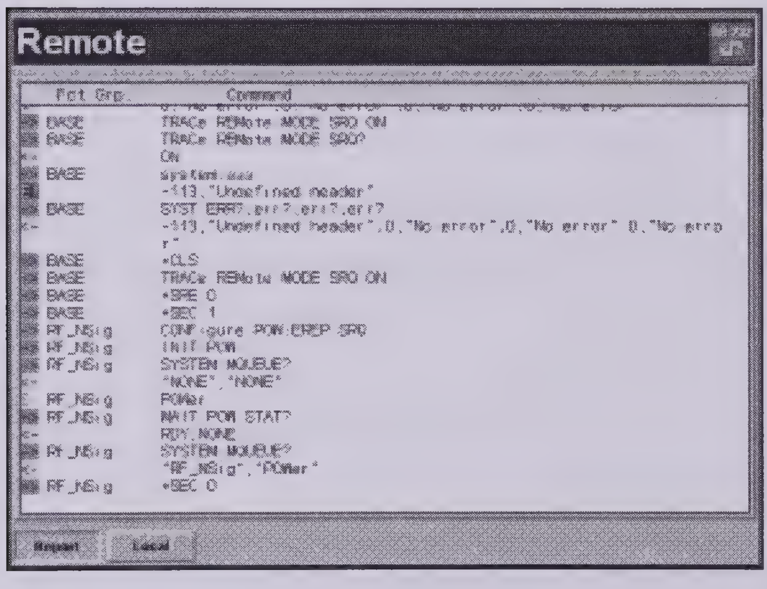
Via RS-232 interface:

- ➢ Use the `SYSTem:REMote:ADDRess:PRIMary <Addr_1>` command to define the GPIB bus address of the CMU.
- ➢ Use the `SYSTem:REMote:ADDRess:SECondary <Addr_2>,"<Fgroup>"` command to assign distinct secondary addresses to all function groups needed.
- ➢ Use the `*SEC <Addr_2>` command for a software switchover from one secondary address to another. Alternatively place `<Addr_2>;` in front of the command:

  `*SEC <Addr_2>` followed by `<Command>` is equivalent to `<Addr_2>;<Command>`, provided that secondary address `<Addr_2>` has been appropriately defined.

Indications during Remote Control

In the REMOTE state no menus but only the header REMOTE is indicated. In addition, input and output strings of the remote-control interface can be displayed by pressing the *Report* hotkey. The *Local* hotkey switches back to manual control.



```
 Fct Grp.        Command
 BASE            TRACe REMote MODE SRQ ON
 BASE            TRACe REMote MODE SRQ?
                 ON
 BASE            [illegible]
                 -113,"Undefined header"
 BASE            SYST:ERR?;err?;err?;err?
                 -113,"Undefined header",0,"No error",0,"No error",0,"No erro
                 r"
 BASE            *CLS
 BASE            TRACe REMote MODE SRQ ON
 BASE            *SRE 0
 BASE            *SEC 1
 RF_NSig         CONFigure:POW:CREP SRQ
 RF_NSig         INIT:POW
 RF_NSig         SYSTEM:MOUBLE?
                 "NONE","NONE"
 RF_NSig         POWer
 RF_NSig         WAIT:POW:STAT?
                 RDY,NONE
 RF_NSig         SYSTEM:MOUBLE?
                 "RF_NSig","POWer"
 RF_NSig         *SEC 0
```

Fig. 5-1 Remote screen

Return to Manual Operation

Return to manual operation can be initiated via the front panel or the GPIB bus.

Manually:

- ➢ Press any key at the front panel.

Note:

- – *Before returning to manual control, command processing must be completed. If this is not the case, the CMU switches back to remote control immediately.*
- – *Returning to manual control by pressing any front panel key can be disabled by the GPIB Local Lockout Message, e.g. with the NI command SetRWLS*

(Set Remote With Lockout State). This prevents unintentional switchover, i.e. return to manual control is possible via the GPIB bus only.

– *Returning to manual control via the front panel keys can be enabled again by deactivating the REN control line of the GPIB bus (see chapter 8).*

Via GPIB bus:

```
...
CALL IBLOC(device%)               Set instrument to manual operation
...
```

Setting the Transmission Parameters (RS-232 interface)

To ensure a correct data transmission, the parameters of the instrument and the controller must be set identically. The number of data and stop bits, the parity, baud rate and the handshake mode can be set independently for the two interfaces COM 1 and COM 2 in the *Setup - Comm.* menu:

- Open *Setup - Comm.* menu,
- Press one of the softkeys to select interface COM 1 or COM 2,
- Use the cursor keys and the rotary knob to select and change desired parameters,
- Terminate input using the *[ENTER]* key.

GPIB Bus Messages

The messages transferred via the data lines of the GPIB bus (see chapter 8) can be divided into two groups:

- **interface messages**
- **device messages**

Interface Message

Interface messages are transferred on the data lines of the GPIB bus, the ATN control line being active. They are used for communication between controller and instrument and can only be sent by a computer which has the function of an GPIB bus controller.

Interface commands can be further subdivided into

- **universal commands**
- **addressed commands**

Universal commands act on all devices connected to the GPIB bus without previous addressing, addressed commands only act on devices previously addressed as listeners. The interface messages relevant to the instrument are listed in chapter 8, section *Interface Messages.*

Device Messages (Commands and Device Responses)

Device messages are transferred via the data lines of the GPIB bus, the "ATN" control line not being active. The ASCII code is used. A distinction is made according to the direction in which device messages are transferred:

Commands are messages the controller sends to the instrument. They operate the device functions and request information. The commands are subdivided according to two criteria:

1. According to the effect they have on the instrument:

Setting commands cause instrument settings such as a reset of the instrument or setting the output level to some value.

Queries cause data to be provided for output on the GPIB bus, e.g. for identification of the device or polling the active input.

2. According to their definition in standard IEEE 488.2:

Common Commands are exactly defined as to their function and notation in standard IEEE 488.2. They refer to functions such as management of the standardized status registers, reset and selftest.

Device-specific Commands refer to functions depending on the features of the instrument such as frequency setting. A majority of these commands has also been standardized by the SCPI committee (cf. section *SCPI Introduction*).

Device responses are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status (cf. section 3.5.4).

Structure and syntax of the device messages are described in the next section. In chapter 6 all commands are listed and explained in detail.

Structure and Syntax of Device Messages

SCPI Introduction

Not all of the commands supported by the instrument are taken from the SCPI standard (Standard Commands for Programmable Instruments), however, their syntax follows SCPI rules. All information given in this section and all the command examples apply to the CMU.

SCPI (Standard Commands for Programmable Instruments) describes a standard command set for programming instruments, irrespective of the type of instrument or manufacturer. The goal of the SCPI consortium is to standardize the device-specific commands to a large extent. For this purpose, a model was developed which defines the same functions inside a device or for different devices. Command systems were generated which are assigned to these functions. Thus it is possible to address the same functions with identical commands. The command systems are of a hierarchical structure. Fig. 5-2 illustrates this tree structure using a section of command system SOURce, which operates the signal sources of the devices. The other examples concerning syntax and structure of the commands are derived from this command system.

SCPI is based on standard IEEE 488.2, i.e. it uses the same syntactic basic elements as well as the common commands defined in this standard. Part of the syntax of the device responses is defined with greater restrictions than in standard IEEE 488.2 (see section *Responses to Queries).*

Command Structure

The commands consist of a so-called header and, in most cases, one or more parameters. Header and parameter are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several key words. Queries are formed by directly appending a question mark to the header.

Common Commands

Common (=device-independent) commands consist of a header preceded by an asterisk "*" and eventually one or several parameters.

Examples:

`*RST`	RESET, resets the instrument.
`*ESE 253`	EVENT STATUS ENABLE, sets the bits of the event status enable registers.
`*ESR?`	EVENT STATUS QUERY, queries the contents of the event status register.

Device-specific commands

Hierarchy: Device-specific commands are of hierarchical structure (see Fig. 5-2). The different levels are represented by combined headers. Headers of the highest level (root level) have only one key word. This key word denotes a complete command system.

Example:

`SOURce` This key word denotes the command system `SOURce`.

For commands of lower levels, the complete path has to be specified, starting on the left with the highest level, the individual key words being separated by a colon ":".

Example:

`SOURce:RFGenerator:FHOPping:STATe ON`

This command is located on the fourth level of the SENse system. It switches on frequency hopping for the RF generator.

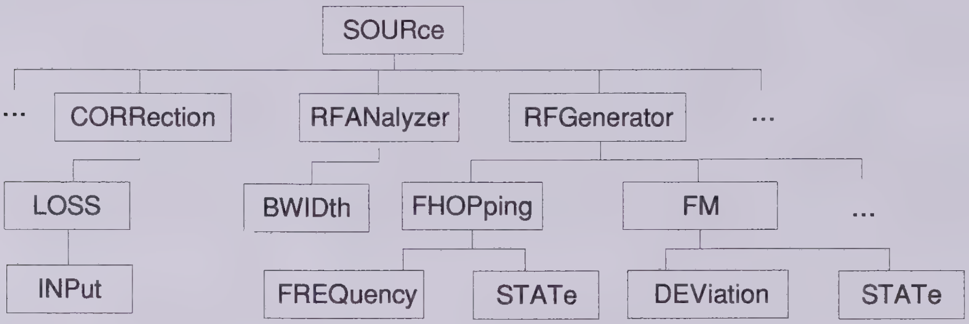


Fig. 5-2 Example for the tree structure of the SCPI command systems; the `SOURce` system

Multiple key words Some key words occur on several levels within one command system. Their effect depends on the structure of the command, i. e. on the position in the command header they are inserted in.

Example: `SOURce:RFGenerator:FHOPping:STATe ON`

This command contains the key word `SOURce` in the first command level. It switches on frequency hopping for the RF generator.

`TRIGger:SOURce EXTern`

This command contains the key word `SOURce` in the second command level. It defines the trigger source "external trigger".

Optional key words: Some command systems permit certain key words to be optionally inserted into the header or omitted. These key words are marked by square brackets in this manual. The full command length must be recognized by the instrument for reasons of compatibility with the SCPI standard. Some commands are considerably shortened by omitting optional key words.

Example: `TRIGger[:SEQuence]:SOURce EXTern`

This command defines the trigger source "external trigger". The following command has the same effect:

`TRIGger:SOURce EXTern`

Note: *An optional key word must not be omitted if its effect is additionally specified by a numeric suffix.*

Long and short form: The key words feature a long form and a short form. Either the short form or the long form can be entered, other abbreviations are not permissible.

Example:

```
TRIGger:SOURce EXTern
TRIG:SOUR EXT
```

Note: *The short form is marked by upper-case letters, the long form corresponds to the complete word. Upper-case and lower-case notation only serves to distinguish the two forms in the manual, the instrument itself does not distinguish upper-case and lower-case letters.*

Parameters: Parameters must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma ",". For a description of the types of parameter, refer to section *Parameters* on page 5.9.

Example: `CONFigure:POWer:CONTrol SCALar,100`

This command defines the type of measured values in a power measurement and the number of samples/bursts forming a statistics cycle.

Numeric suffix: If a device features several functions or features of the same kind, e.g. several inputs, the desired function can be selected by a suffix added to the command. Entries without suffix are interpreted like entries with the suffix 1.

Example: `SOURce:CORRection:LOSS:INPut2 10dB`

This command defines the external attenuation at the input connector RF 2

Structure of a Command Line

A command line may consist of one or several commands. It is terminated by a <New Line>, a <New Line> with EOI or an EOI together with the last data byte. Visual BASIC automatically produces an EOI together with the last data byte.

Several commands in a command line must be separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

Example: `CALL IBWRT(device%, "TRIGger:SOURce EXTern;:FETch:POWer:STATus?")`

This command line contains two commands. The first command belongs to the `TRIGger` system and defines the trigger source (external trigger). The second command belongs to the `FETCh` system and returns the status of the power measurement.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels (see also Fig. 5.1). The colon following the semicolon must be omitted in this case.

Example: `CALL IBWRT(device%, "TRIG:SOUR EXT;:TRIG:THR LOW")`

This command line is represented in its full length and contains two commands separated from each other by the semicolon. Both commands are part of the `TRIGger` command system, i.e. they have one level in common.
When abbreviating the command line, the second command begins with the level below `TRIG`. The colon after the semicolon is omitted.

The abbreviated form of the command line reads as follows:

`CALL IBWRT(device%, "TRIG:SOUR EXT;THR LOW")`

However, a new command line always begins with the complete path.

Example:

```
CALL IBWRT(device%, "TRIG:SOUR EXT ")
CALL IBWRT(device%, "TRIG:THR LOW ")
```

Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

1. The requested parameter is transmitted without header.
   Example: `TRIGger:THReshold?` Response: `LOW`
2. Maximum values, minimum values and all further quantities, which are requested via a special text parameter are returned as numerical values
   Example: `CONFigure:POWer:CONTrol:REPetition? MAX` Response: `10000`
3. Numerical values are output without a unit. Physical quantities are referred to the basic units or to the units set using the Unit command.
   Example: `SENSe:SPECtrum:FREQuency:STARt?` Response: `1E6` for 1 MHz
4. Boolean values are returned as 0 (for OFF) and 1 (for ON).
   Example: `SOURce:DM:CLOCk:STATe?` Response: `1`
5. Text (character data) is returned in a short form (see also next section).
   Example: `FETCh:SPECtrum:STATus?` Response: `ERR`

Parameters

Most commands require a parameter to be specified. The parameters must be separated from the header by a "white space". Permissible parameters are numerical values, Boolean parameters, text, character strings and block data. The type of parameter required for the respective command and the permissible range of values are specified in the command description.

Numerical values

Numerical values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not permissible. In the case of physical quantities, the unit can be entered. Permissible unit prefixes are G (giga), MA (mega), MOHM and MHZ are also permissible), K (kilo), M (milli), U (micro) and N (nano). If the unit is missing, the basic unit is used (see also section *Unit Rings* below).

Example: `SENS:SPEC:FREQ:STOP 1.5GHz` is equivalent to
`SENS:SPEC:FREQ:STOP 1.5E9`

Special numerical values

The texts MINimum, MAXimum, DEFault, UP and DOWN are interpreted as special numerical values.

In the case of a query, the associated numerical value is provided.

Example: Setting command: `CONF:POW:CONT:REP MAXimum`
Query: `CONF:POW:CONT:REP?`
Response: `100`

MIN/MAX MINimum and MAXimum denote the minimum and maximum value.

DEF DEFault denotes a preset value. This value conforms to the default setting, as it is called by the *RST command.

INF/NINF INFinity, Negative INFinity (NINF) represent the numerical values -9.9E37 or 9.9E37, respectively. INF and NINF are only sent as device responses.

NAN Not a Number (NAN) represents the value 9.91E37. NAN is only sent as device response. This value is not defined. Possible causes are division by zero, subtraction or addition of infinite and the representation of missing values.

Boolean Parameters Boolean parameters represent two states. The ON state (logically true) is represented by ON or a numerical value unequal to 0. The OFF state (logically untrue) is represented by OFF or the numerical value 0. ON or OFF is provided in a query.

Example: Setting command: `SOURce:DM:CLOCk:STATe ON`
Query: `SOURce:DM:CLOCk:STATe?`
Response: `ON`

Text Text parameters observe the syntactic rules for key words, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

Example: Setting command: `TRIGger:SOURce EXTern`
Query: `TRIGger:SOURce?` Response: `EXT`

Strings Strings must always be entered within quotation marks (' or ").

Example: `:SYST:REM:ADDR:SEC 1,"GSM900MS_NSig"` or
`:SYST:REM:ADDR:SEC 1,'GSM900MS_Nsig'`

Block data Block data are a transmission format which is suitable for the transmission of large amounts of data. A command using a block data parameter has the following structure:

Example: `:HEADer:HEADer #45168xxxxxxxx`

The double dagger # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all End or other control signs are ignored until all bytes are transmitted.

Overview of Syntax Elements

The following survey offers an overview of the syntax elements.

:	The colon separates the key words of a command. In a command line the separating semicolon marks the uppermost command level.
;	The semicolon separates two commands of a command line. It does not alter the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*	The asterisk marks a common command.
"	Quotation marks introduce a string and terminate it.
#	The double dagger # introduces binary, octal, hexadecimal and block data. Binary: #B10110 Octal: #O7612 Hexa: #HF3A7 Block: #21313...
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates header and parameter.

Instrument Model and Command Processing

The block diagram in figure Fig. 5-3 shows how GPIB bus commands are serviced in the instrument. The individual components work independently and simultaneously. They communicate with each other by means of so-called "messages".

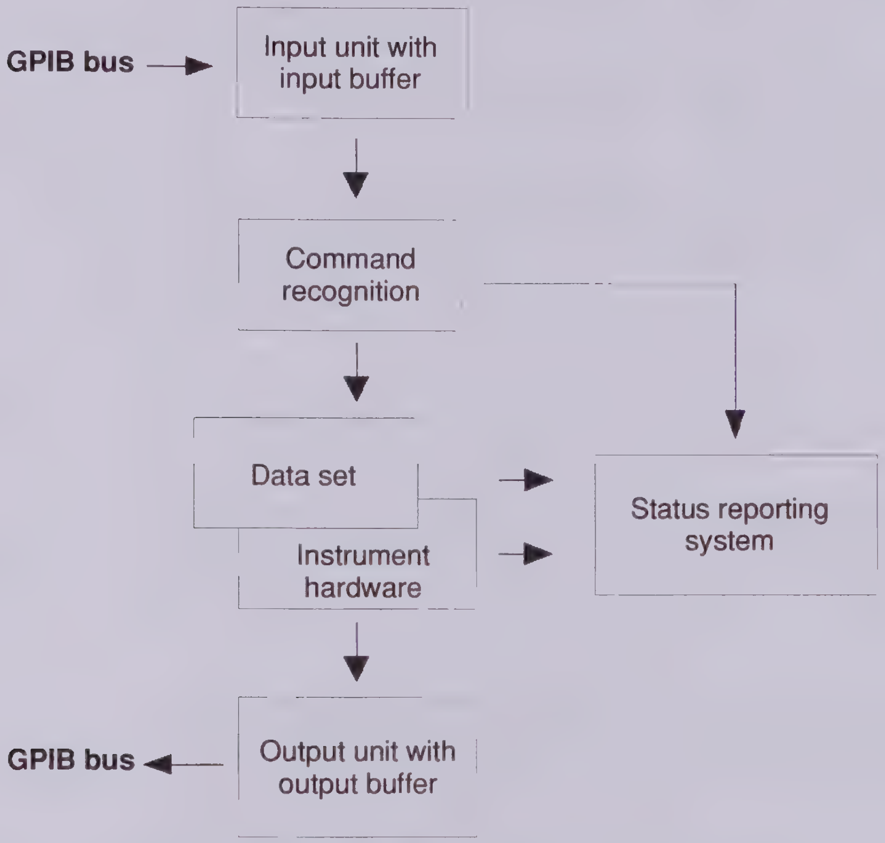

GPIB bus
Input unit with input buffer
Command recognition
Data set
Instrument hardware
Status reporting system
GPIB bus
Output unit with output buffer

Fig. 5-3 Instrument model in the case of remote control via GPIB bus

Input Unit

The input unit receives commands character by character from the GPIB bus and collects them in the input buffer. The input unit sends a message to the command recognition as soon as the input buffer is full or as soon as it receives a delimiter, <PROGRAM MESSAGE TERMINATOR>, as defined in IEEE 488.2, or the interface message DCL.

If the input buffer is full, the GPIB bus traffic is stopped and the data received up to then are processed. Subsequently the GPIB bus traffic is continued. If, however, the buffer is not yet full when receiving the delimiter, the input unit can already receive the next command during command recognition and execution. The receipt of a DCL clears the input buffer and immediately initiates a message to the command recognition.

Command Recognition

The command recognition analyses the data received from the input unit. It proceeds in the order in which it receives the data. Only a DCL is serviced with priority, a GET (Group Execute Trigger), e.g., is only executed after the commands received before. Each recognized command is immediately transmitted to the data set but not executed immediately.

Syntactical errors in the command are recognized here and transferred to the status reporting system. The rest of a command line after a syntax error is ignored.

If the command recognition recognizes a delimiter or a DCL, it requests the data set to set the commands in the instrument hardware as well. Subsequently it is immediately prepared to process commands again. This means for the command servicing that further commands can already be serviced while the hardware is still being set ("overlapping execution").

Data Set and Instrument Hardware

The expression "instrument hardware" denotes the part of the instrument fulfilling the actual instrument function - signal generation, measurement etc. The controller is not included.

The data set is a detailed software reproduction of the instrument hardware.

GPIB bus setting commands lead to an alteration in the data set. The data set management enters the new values (e.g. frequency) into the data set, however, only passes them on to the hardware when requested by the command recognition. As this is always only effected at the end of a command line, the order of the setting commands in the command line is not relevant.

The data are only checked for their compatibility among each other and with the instrument hardware immediately before they are transmitted to the instrument hardware. If the detection is made that execution is not possible, an "execution error" is signaled to the status reporting system. All alterations of the data set are canceled, the instrument hardware is not reset. Due to the delayed checking and hardware setting, however, impermissible instrument states can be set for a short period of time within one command line without this leading to an error message (example: simultaneous activation of FM and PM). At the end of the command line, however, a permissible instrument state must have been reached again.

Before passing on the data to the hardware, the settling bit in the STATus:OPERation register is set (cf. section *STATus:OPERation* Register). The hardware executes the settings and resets the bit again as soon as the new state has settled. This fact can be used to synchronize command servicing.

GPIB bus queries induce the data set management to send the desired data to the output unit.

Status Reporting System

The status reporting system collects information on the instrument state and makes it available to the output unit on request. The exact structure and function are described in section Status Reporting System on page 5.15.

Output Unit

The output unit collects the information requested by the controller, which it receives from the data set management. It processes it according to the SCPI rules and makes it available in the output buffer. If the information requested is longer, it is made available "in portions" without this being recognized by the controller.

If the instrument is addressed as a talker without the output buffer containing data or awaiting data from the data set management, the output unit sends error message "Query UNTERMINATED" to the status reporting system. No data are sent on the GPIB bus, the controller waits until it has reached its time limit. This behavior is specified by SCPI.

Command Sequence and Command Synchronization

What was said above makes clear that overlapping execution is possible in principle for all commands. Equally, setting commands within one command line are not absolutely serviced in the order in which they have been received.

In order to make sure that commands are actually carried out in a certain order, each command must be sent in a separate command line, that is to say, with a separate IBWRT()-call.
In order to prevent an overlapping execution of commands, one of commands *OPC, *OPC? or *WAI must be used. All three commands cause a certain action only to be carried out after the hardware has been set and has settled. By a suitable programming, the controller can be forced to wait for the respective action to occur (cf. Table 5-1).

Table 5-1 Synchronization with *OPC, *OPC? and *WAI

Command	Action after the hardware has settled	Programming the controller
*OPC	Setting the operation-complete bit in the ESR	- Setting bit 0 in the ESE - Setting bit 5 in the SRE - Waiting for service request (SRQ)
*OPC?	Writing a "1" into the output buffer	Addressing the instrument as a talker
*WAI	Executing the next command Note: The GPIB bus handshake is not stopped	Sending the next command

Status Reporting System

The status reporting system (cf. Fig. 5-5) stores all information on the present operating state of the instrument, e.g. that the instrument presently carries out an AUTORANGE and on errors which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via GPIB bus.

The information is of a hierarchical structure. The register status byte (STB) defined in IEEE 488.2 and its associated mask register service request enable (SRE) form the uppermost level. The STB receives its information from the standard event status register (ESR) which is also defined in IEEE 488.2 with the associated mask register standard event status enable (ESE) and registers STATus:OPERation and STATus:QUEStionable which are defined by SCPI and contain detailed information on the instrument.

The IST flag ("Individual STatus") and the parallel poll enable register (PPE) allocated to it are also part of the status reporting system. The IST flag, like the SRQ, combines the entire instrument status in a single bit. The PPE fulfills an analog function for the IST flag as the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB and thus is represented in Fig. 5-5.

Structure of an SCPI Status Register

Each SCPI register consists of 5 parts which each have a width of 16 bits and have different functions (cf. Fig. 5-4). The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is valid for all five parts. For example, bit 3 of the STATus:OPERation register is assigned to the hardware status "wait for trigger" in all five parts. Bit 15 (the most significant bit) is set to zero for all parts. Thus the contents of the register parts can be processed by the controller as positive integer.

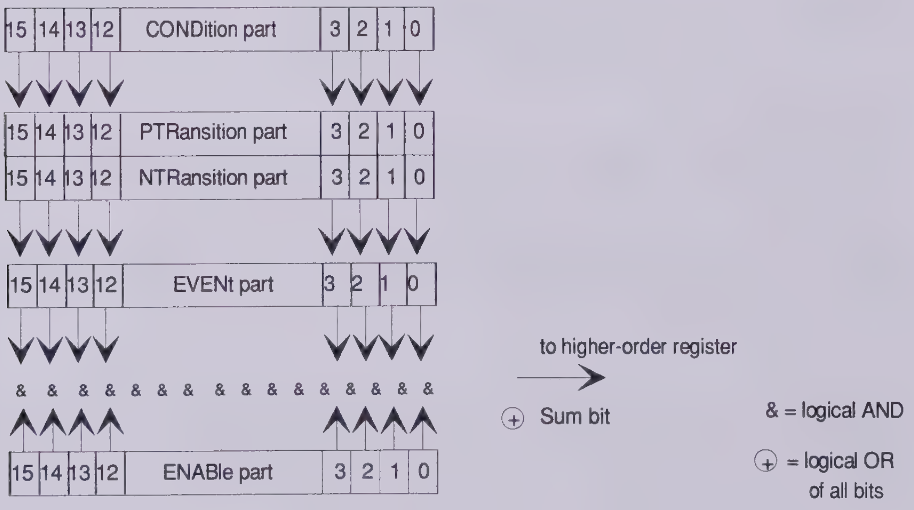


Fig. 5-4 The status register model

CONDition part

The CONDition part is directly written into by the hardware or the sum bit of the next lower register. Its contents reflects the current instrument status. This register part can only be read, but not written into or cleared. Its contents is not affected by reading.

PTRansition part

The Positive-TRansition part acts as an edge detector. When a bit of the CONDition part is changed from 0 to 1, the associated PTR bit decides whether the EVENt bit is set to 1.
PTR bit =1: the EVENt bit is set.
PTR bit =0: the EVENt bit is not set.
This part can be written into and read at will. Its contents is not affected by reading.

NTRansition part

The Negative-TRansition part also acts as an edge detector. When a bit of the CONDition part is changed from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.
NTR bit =1: the EVENt bit is set.
NTR bit =0: the EVENt bit is not set.
This part can be written into and read at will. Its contents is not affected by reading.

With these two edge register parts the user can define which state transition of the condition part (none, 0 to 1, 1 to 0 or both) is stored in the EVENt part.

EVENt part

The EVENt part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the edge filters. It is permanently updated by the instrument. This part can only be read by the user. Upon reading, its contents is set to zero. In colloquial language, this part is often equated with the entire register.

ENABle part

The ENABle part determines whether the associated EVENt bit contributes to the sum bit (cf. below). Each bit of the EVENt part is ANDed with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an OR function (symbol '+').
ENAB bit =0: the associated EVENt bit does not contribute to the sum bit
ENAB bit =1: if the associated EVENT bit is "1", the sum bit is set to "1" as well.
This part can be written into and read by the user at will. Its contents is not affected by reading.

Sum bit

As indicated above, the sum bit is obtained from the EVENt and ENABle part for each register. The result is then entered into a bit of the CONDition part of the higher-order register.
The instrument automatically generates the sum bit for each register. Thus an event, e.g. a PLL that has not locked, can lead to a service request throughout all levels of the hierarchy.

Note:

The service request enable register SRE defined in IEEE 488.2 can be taken as ENABle part of the STB if the STB is structured according to SCPI. By analogy, the ESE can be taken as the ENABle part of the ESR.

Overview of the Status Registers

Fig. 5-5 shows the status registers used in the CMU. The STATus:QUEStionable register is not used. In addition to the standard STATus:OPERation register, the CMU offers 30 independent STATus:OPERation:CMU:SUM1|2:CMU<nr> sub-registers (<nr>=1 ... 15).

Cascading registers

The hierarchical structure of the STATus:OPERation register was designed with the aim of reporting and specifying the events generated during different measurements independently. Each sub-register receives entries from a particular combination of a function group and signalling mode (e.g. *RF Non Signalling, GSM900-MS Signalling* etc.). The function groups and modes are identified by means of their secondary address, an integer number between 1 and 30 which can be arbitrarily assigned or queried via the `SYSTem:REMote:ADDRess:SECondary` command (see chapter 6). The assignment between sub-registers and secondary address is as follows:

Sub-register	Sec. Address	Sub-register	Sec. Address
STAT:OPER:SUM1:CMU1	1	STAT:OPER:SUM2:CMU1	16
...	...	...	...
STAT:OPER:SUM1:CMU15	15	STAT:OPER:SUM2:CMU15	30

Contents of the sub-registers

The higher-level STATus:OPERation registers summarize the sub-registers as shown in Fig. 5-5. E.g., if the corresponding ENABle bit is set, any EVENt reported in one of the STATus:OPERation:CMU:SUM1|2:CMU<nr> sub-registers sets the sum bit of the STATus:OPERation:CMU:SUM1|2 register to 1.

This means that the STATus:OPERation register indicates whether any event occurred, the lower-level STATus:OPERation:CMU:SUM1|2 registers indicate the function group and signalling mode in which the event occurred, the lowest-level STATus:OPERation:CMU:SUM1|2 registers indicate the nature of the individual events.

The meaning of the bits in function group *RF Non Signalling* is given below (see section STATus:OPERation Register 5.21). For other function groups refer to the relevant manuals.

Accessing the sub-registers

Every single status register can be configured and queried individually by means of the commands of the STATus:OPERation subsystem (see chapter 6).

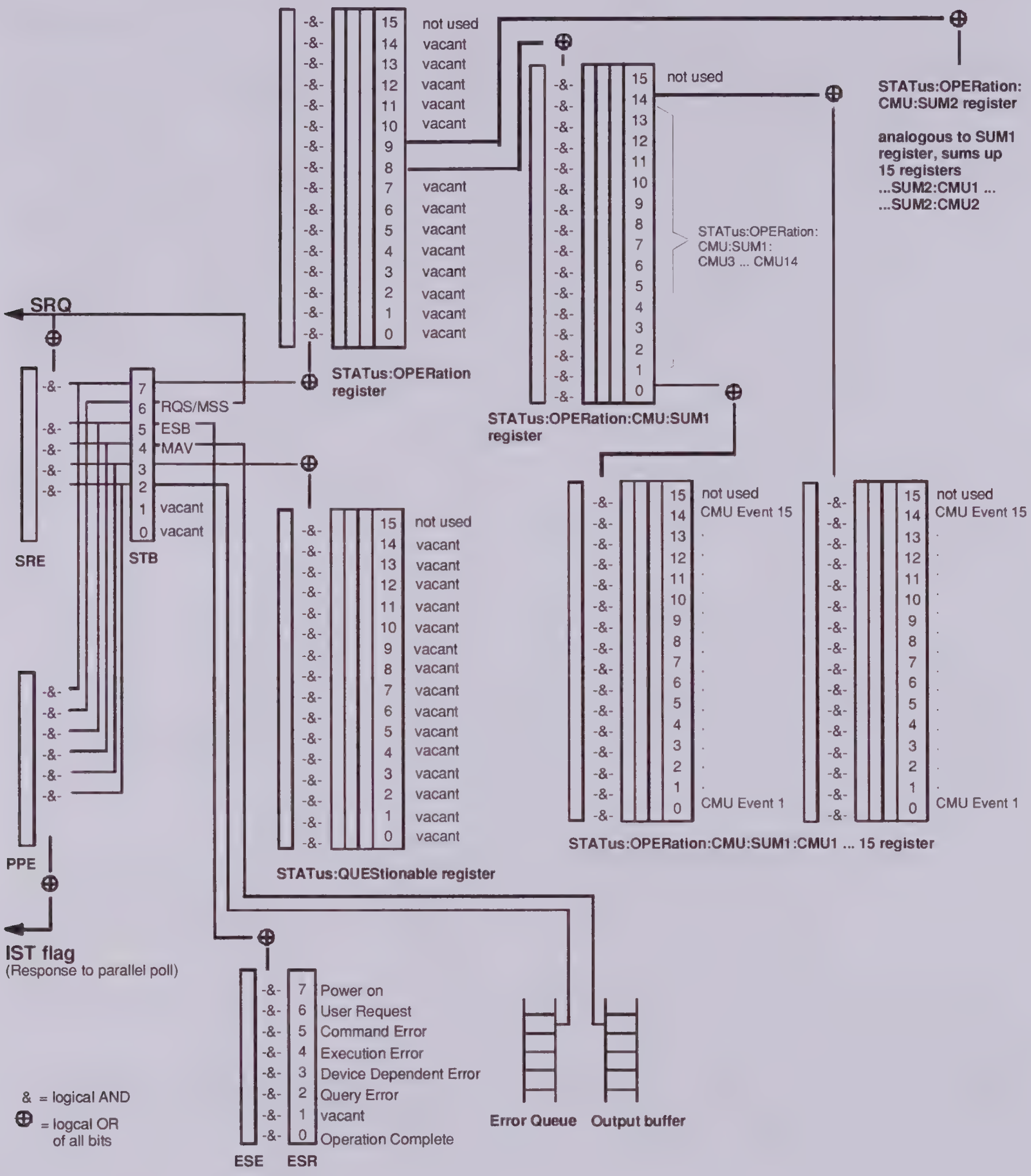

15 not used
14 vacant
13 vacant
12 vacant
11 vacant
10 vacant
9
8
7 vacant
6 vacant
5 vacant
4 vacant
3 vacant
2 vacant
1 vacant
0 vacant
STATus:OPERation register
15 not used
14
13 ... 0
STATus:OPERation:CMU:SUM1:CMU3 ... CMU14
STATus:OPERation:CMU:SUM1 register
STATus:OPERation:CMU:SUM2 register
analogous to SUM1 register, sums up 15 registers ...SUM2:CMU1 ... ...SUM2:CMU2
15 not used
14 CMU Event 15
0 CMU Event 1
15 not used
14 CMU Event 15
0 CMU Event 1
STATus:OPERation:CMU:SUM1:CMU1 ... 15 register
SRQ
-&-
7
6 RQS/MSS
5 ESB
4 MAV
3
2
1 vacant
0 vacant
SRE
STB
15 not used
14 vacant
13 vacant
12 vacant
11 vacant
10 vacant
9 vacant
8 vacant
7 vacant
6 vacant
5 vacant
4 vacant
3 vacant
2 vacant
1 vacant
0 vacant
STATus:QUEStionable register
PPE
IST flag
(Response to parallel poll)
7 Power on
6 User Request
5 Command Error
4 Execution Error
3 Device Dependent Error
2 Query Error
1 vacant
0 Operation Complete
ESE
ESR
Error Queue
Output buffer
& = logical AND
⊕ = logcal OR of all bits

Fig. 5-5 The status registers

Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. It can thus be compared with the CONDition part of an SCPI register and assumes the highest level within the SCPI hierarchy. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.

The STATUS BYTE is read out using the command "*STB?" or a serial poll.

The STB is linked to the SRE. The latter corresponds to the ENABle part of the SCPI registers in its function. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a Service Request (SRQ) is generated on the GPIB bus, which triggers an interrupt in the controller if this is appropriately configured and can be further processed there.
The SRE can be set using command "*SRE" and read using "*SRE?".

Table 5-2 Meaning of the bits used in the status byte

Bit no.	Meaning
2	**Error Queue not empty** The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a Service Request. Thus an error can be recognized and specified in greater detail by polling the error queue. The poll provides an informative error message. This procedure is to be recommended since it considerably reduces the problems involved with GPIB bus control.
3	**QUEStionable status sum bit** The bit is set if an EVENt bit is set in the QUEStionable status register and the associated ENABle bit is set to 1. A set bit indicates a questionable instrument status, which can be specified in greater detail by polling the QUEStionable status register.
4	**MAV-Bit** (Message AVailable) The bit is set if a message is available in the output buffer which can be read. This bit can be used to enable data to be automatically read from the instrument to the controller (cf. annex D, program examples).
5	**ESB bit** Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting of this bit indicates a serious error which can be specified in greater detail by polling the event status register.
6	**MSS-Bit** (Master Status Summary bit) The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this register is set together with its mask bit in the service request enable register SRE.
7	**OPERation status register sum bit** The bit is set if an EVENt bit is set in the OPERation status register and the associated ENABle bit is set to 1. A set bit indicates that the instrument is just performing an action. The type of action can be queried by polling the OPERation status register.

IST Flag and Parallel Poll Enable Register (PPE)

By analogy with the SRQ, the IST flag combines the entire status information in a single bit. It can be queried by means of a parallel poll (cf. Section *Parallel Poll* on page 5.23) or using the command "`*IST?`".

The parallel poll enable register (PPE) determines which bits of the STB contribute to the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE, with bit 6 being used as well in contrast to the SRE. The IST flag results from the ORing of all results. The PPE can be set using commands "*PRE" and read using command "`*PRE?`".

Event Status Register (ESR) and Event Status Enable Register (ESE)

The ESR is defined in IEEE 488.2. It can be compared with the EVENt part of an SCPI register. The event status register can be read out using command "`*ESR?`".
The ESE is the associated ENABle part. It can be set using the command "`*ESE`" and read using the command "`*ESE?`".

Table 5-3 Meaning of the bits used in the event status register

Bit No.	Meaning
0	**Operation Complete** This bit is set on receipt of the command *OPC exactly when all previous commands have been executed.
2	**Query Error** This bit is set if either the controller wants to read data from the instrument without having sent a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is faulty and hence cannot be executed.
3	**Device-dependent Error** This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
4	**Execution Error** This bit is set if a received command is syntactically correct but cannot be performed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
5	**Command Error** This bit is set if a command which is undefined or syntactically incorrect is received. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the error queue (cf. annex B, Error Messages).
6	**User Request** This bit is not used in the CMU.
7	**Power On** (supply voltage on) This bit is set on switching on the instrument.

STATus:OPERation Register

The CMU offers 30 independent STATus:OPERation:CMU:SUM1|2:CMU<nr> sub-registers (<nr>=1 ... 15) which are implemented in hierarchical form. The bits of the 30 STATus:OPERation registers are set only after the registers are assigned to a function group and measurement mode (see p. 5.17).

In the CONDition part, the STATus:OPERation register contains information on which actions the instrument is being executing or, in the EVENt part, information on which actions the instrument has executed since the last readout. All fife parts of the registers can be read using one of the commands of the subsystem `STATus:OPERation:CMU:SUM1|2:CMU<nr>:...` . Moreover, the EVENt part can be enabled and read by means of the `STATus:OPERation:SYMBolic...` commands, see section Symbolic Status Event Register Evaluation on page 5.23 ff.

For function group *RF Non Signalling,* the bit assignment is as follows:

Table 5-4 Meaning of the bits used in the `STATus:OPERation:CMU:SUM1|2:CMU<nr>` sub-register assigned to *RF Non Signalling*

Bit-No.	Meaning	Symbol in `STATus:OPERation:SYMBolic...`
0	**Overload** This bit is set while the currently used input connector is overloaded.	**IOV**

For optional function groups refer to the relevant manuals.

STATus:QUEStionable-Register

This register contains information on questionable instrument states. They can occur, e.g. if the instrument is operated outside its specified range. It can be queried using one of the commands `":STATus:QUEStionable:CONDition?"` or `":STATus:QUEStionable[:EVENt]?"`.

The CMU does not use this register.

Application of the Status Reporting Systems

In order to effectively use the status reporting system, the information contained there must be transmitted to the controller and further processed there. There are several methods which are outlined in the following.

Service Request

Under certain circumstances, the instrument can send a service request (SRQ) to the controller. Usually this service request initiates an interrupt at the controller, to which the control program can react appropriately. As evident from Fig. 5-5, an SRQ is always initiated if one or several of bits 2, 3, 4, 5 or 7 of the status byte are set and enabled in the SRE. Each of these bits combines the information of a further register, the error queue or the output buffer. The corresponding setting of the ENABle parts of the status registers can achieve that arbitrary bits in an arbitrary status register initiate an SRQ. In order use the possibilities of the service request effectively, all bits should be set to "1" in the enable registers SRE and ESE.

Examples (cf. Fig. 5-5):

Use command "`*OPC`" to generate an SRQ

- Set bit 0 in the ESE (Operation Complete)
- Set bit 5 in the SRE (ESB)

After its settings have been completed, the instrument generates an SRQ.

Indication of an event (e.g. overloading of used input connector) by means of an SRQ with the controller:

- Set bit 7 in the SRE (sum bit of the STATus:OPERation register)

The following steps depend on the secondary address (1 ≤ <SecAddr> ≤ 30) assigned to the function group and signalling mode used.

1 ≤ <SecAddr> ≤ 15

- Set bit 8 in the STATus:OPERation:ENABle register.
- Set bit <SecAddr>-1 in the STATus:OPERation:CMU:SUM1:ENABle register
- Set bit 0 in the STATus:OPERation:CMU:SUM1:CMU<SecAddr>:ENABle register.

16 ≤ <SecAddr> ≤ 30

- Set bit 9 in the STATus:OPERation:ENABle register.
- Set bit <SecAddr>-16 in the STATus:OPERation:CMU:SUM2:ENABle register
- Set bit 0 in the STATus:OPERation:CMU:SUM2:CMU<SecAddr>:ENABle register.

When the event assigned to bit no. 0 of the STATus:OPERation:CMU:SUM1|2:CMU<SecAddr> register occurs (e.g. when the input connector is overloaded in function group *RF Non Signalling)* the instrument generates a SRQ.

The same procedure can be applied to find out which event caused an SRQ:

- `STB?`
- Query `STAT:OPER:EVENT?`
- Query `STAT:OPER:CMU:SUM1|2:EVENT?` (function group, signalling mode)
- Query `STAT:OPER:CMU:SUM1|2:CMU1...15:EVENT?` (measurement)

The SRQ is the only possibility for the instrument to become active on its own. Each controller program should set the instrument such that a service request is initiated in the case of malfunction. The program should react appropriately to the service request.

Symbolic Status Event Register Evaluation

The examples status register handling given in section *Service Request* on p. 5.22 are based on a step-by-step evaluation of the `STATus:OPERation` register and its sub-registers. As a convenient alternative to this approach, the CMU provides commands for symbolic status event register evaluation. These commands are global (i.e. available in all function groups) and described in detail in chapter 6. They organize and simplify the following actions:

`STATus:OPERation:EVENt:SADDress?`	Return the next secondary address and associated function group where an event was reported.
`STATus:OPERation:SYMBolic:ENABle <Event_1>[,<Event_2>,...<Event_15>]`	Enable the events of the parameter list up to the status byte, i.e. set the corresponding bits in the `STATus:OPERation:ENABle` register and in the sub-registers `STATus:OPERation:CMU:SUM1|2:ENABle` and `STATus:OPERation:CMU:SUM1|2:CMU <SecAddr>:ENABle` so that the events are reported in the status byte. <SecAddr> denotes the current secondary address, see also example in section *Service Request* on p. 5.22.
`STATus:OPERation:SYMBolic[:EVENt]?`	Return all events reported in the current function group. The event symbols listed with the bit assignment of the `STATus:OPERation...` registers; for an example see Table 5-4 on page 5.21.

Serial Poll

In a serial poll, just as upon the command "`*STB`", the status byte of an instrument is queried. However, the query is made via interface messages and is thus clearly faster. The serial-poll method has already been defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works for instruments which do not adhere to SCPI or IEEE 488.2.

The quick-BASIC command for executing a serial poll is "`IBRSP()`". The serial poll is mainly used to obtain a fast overview of the state of several instruments connected to the GPIB bus.

Parallel Poll

In a parallel poll, up to eight instruments are simultaneously requested by the controller by means of a single command to transmit 1 bit of information each on the data lines, i.e., to set the data line allocated to each instrument to a logic "0" or "1". By analogy to the SRE register which determines under which conditions an SRQ is generated, there is a parallel poll enable register (PPE) which is ANDed with the STB bit by bit, considering bit 6 – AND as well. The results are ORed, the result is then sent (possibly inverted) as a response to the parallel poll of the controller. The result can also be queried without parallel poll by means of the command "`*IST`".

The instrument first has to be set for the parallel poll using the quick-BASIC command "`IBPPC()`". This command allocates a data line to the instrument and determines whether the response is to be inverted. The parallel poll itself is executed using "`IBRPP()`".

The parallel-poll method is mainly used in order to quickly find out after an SRQ which instrument has sent the service request if there are many instruments connected to the GPIB bus. To this effect, SRE and PPE must be set to the same value.

Query by Means of Commands

Each part of any status register can be read by means of queries. The individual commands are listed in chapter 6. What is returned is always a number which represents the bit pattern of the register queried. This number is evaluated by the controller program.

Queries are usually used after an SRQ in order to obtain more detailed information on the cause of the SRQ.

Error Queue Query

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain-text error messages which can be looked at in the ERROR menu via manual control or queried via the GPIB bus using command `"SYSTem:ERRor?"`. Each call of `"SYSTem:ERRor?"` provides one entry from the error queue. If no error messages are stored there any more, the instrument responds with 0, "No error".

The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

Reset Values of the Status Reporting Systems

Table 5-5 comprises the different commands and events causing the status reporting system to be reset. None of the commands, except for *RST and SYSTem:PRESet influences the functional instrument settings. In particular, DCL does not change the instrument settings.

Table 5-5 Resetting instrument functions

Event	**Switching on supply voltage**		**DCL,SDC**			
	Power-On-Status-Clear		**(Device Clear, Selected Device Clear)**	***RST or SYSTem:PRESet**	**STATus:PRESet**	***CLS**
Effect	**0**	**1**				
Clear STB,ESR	—	yes	—	—	—	yes
Clear SRE,ESE	—	yes	—	—	—	—
Clear PPE	—	yes	—	—	—	—
Clear EVENt parts of the registers	—	yes	—	—	—	yes
Clear ENABle parts of all OPERation-and QUEStionable registers, Fill ENABle parts of all other registers with "1".	—	yes	—	—	yes	—
Fill PTRansition parts with „1" Clear NTRansition parts	—	yes	—	—	yes	—
Clear error queue	yes	yes	—	—	—	yes
Clear output buffer	yes	yes	yes	1)	1)	1)
Clear command processing and input buffer	yes	yes	yes	—	—	—

1) Every command being the first in a command line, i.e. immediately following a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.

Measurement Control

The CMU offers a variety of measurements which are arranged in function groups and measurement groups. All measurements are controlled according to the same basic concepts. The benefit of this structure lies in the close analogy of all function groups. Commands belonging to different measurements have the same structure and syntax.

The following sections are devoted to the principles of measurement control:

- A measurement group can be split up into different subgroups by means of *applications* (optional, i.e. not available for every measurement group).
- Four different measurement states are defined; they can be accessed with a set of measurement control commands.
- The end of the measurement (or of a particular measurement stage) can be indicated by means of *the event reporting system.*
- Statistical settings comprising the repetition mode, statistic count (optional), stop condition (optional), and display mode (optional) control how the measurement is performed. The possible measurement states depend on the repetition mode.
- The current status and the results of the measurement can be queried in a systematic way.

Some measurements do not require the full scheme. E.g., the function group *RF Non Signalling* described in this manual uses none of the features characterized as optional in the above enumeration. Examples for these features can be found in the operating manuals for digital network tests, e.g., *GSM900/1800/1900-MS.*

Applications

Applications are different measurements belonging to the same measurement group. Each application is assigned its own set of configuration parameters. With few exceptions (e.g. some tolerance values), all parameters assigned to the applications can be different from each other. Thus, applications effectively split up a measurement group into various independent subgroups which can be configured individually and serviced in parallel.

The benefit of this feature is that the results of an application will not become invalid when another application in the same measurement group is started.

Applications are generally identified by the third-level keyword in a command while the measurement group is identified by the second-level keyword. Examples can be found in the operating manuals for the network tests.

Measurement Control Commands and States

Measurement control commands are used to switch over between the following four measurement states:

OFF	measurement is switched off, no results available (after `STOP`)
RUN	measurement is running
STOP	measurement has been stopped, valid results are preserved
STEP	measurement has been interrupted after a statistics cycle (in repetition mode *Continuous* or *Counting* with *Stepping* mode set in addition). The next cycle must be launched with a `CONTinue` command.

The *STOP* state corresponds to the *HLT* state indicated next to the softkeys controlling a measurement in manual operation. A *STEP* state is not defined in manual control.

The three measurement states *OFF, STOP,* and *STEP* can be mapped onto the standard SCPI state *IDLE*, the *RUN* state can be mapped onto the SCPI state *INITiated.* This and the relation between control commands and measurement states is shown in the following diagram:

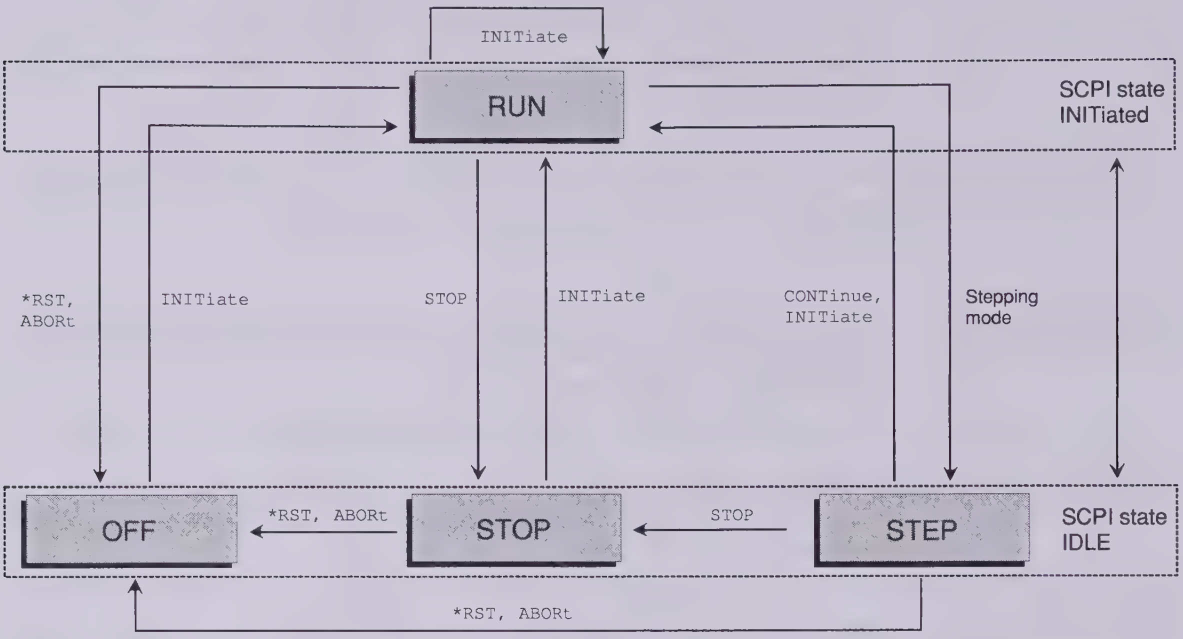


Fig. 5-7 Measurement states and control commands

The measurement control commands are supplemented by the measurement object, i.e.:

`INITiate:<meas_obj>` Starts a measurement in the repetition mode set via the `CONFigure:<meas_obj>:CONTrol:REPetition` command (single shot, continuous or counting mode, see section *Measurement Statistics* on page 5.32). The command resets the counters for the evaluation period and statistics (the latter is not used in RF measurements) to zero, furthermore, all measurement values are set invalid *(INV).*

As illustrated in Fig. 5-7, `INITiate` can be called in any measurement state. If the measurement is already running *(RUN),* `INITiate` aborts `(ABORt)` and restarts a running measurement.

The measurement reserves all necessary hardware resources and switches into the *RUN* state. If the measurement can not be started due to a resources conflict it remains in the *OFF* state, and the measurement status returned by the `FETCh:<meas_obj>:STATus?` is *ERR.* At the same time the SCPI error –213, *Init ignored*, is generated.

Possible resources conflicts

The RF connector is already allocated by another measurement or signal generator. The other measurement must be switched off first.

Due to the method used for the analysis, two measurements can not be evaluated at the same time.

Overlapping execution

`INITiate` is implemented as an overlapped command. In contrast to SCPI specifications, the `*OPC` command (see chapter 6, *Common Commands)* can not be applied together with the `INITiate` command. The *operation complete* bit (bit no. 0 in the event status register, ESR) is set immediately after the command sequence `INIT; *OPC`, i.e. as soon as the measurement is started and not after the end of the first evaluation period.

The command `CONFigure:<meas_obj>:EREPorting <Event>, <Mode>` represents a more flexible tool for generating a service request or setting the *operation complete* bit after the end of a measurement (see section *Event Reporting* on page 5.29).

`READ` command

Instead of `INITiate`, the `READ` command can be used to initiate a (single shot) measurement, see section *Retrieving Measurement Results* on page 5.33.

`ABORt:<meas_obj>`

Aborts the current measurement immediately and switches over to the *OFF* state. All measurement values are set invalid *(INV);* the hardware resources are released for other measurements.

As illustrated in Fig. 5-7, `ABORt` can be called in any measurement state.

Sequential execution

`ABORt` is implemented as a sequential command. This means that `ABORt` ist not complete until the measurement has released all resouces and has changed to the *OFF* state.

`STOP:<meas_obj>`

Stops (halts) the measurement as quickly as possible; i.e. after the end of the current evaluation period (or statistics cycle, if cycles comprising several evaluation periods are defined). The measurement changes to the *STOP* state such that all corresponding measurement values are kept unchanged. The hardware resources are retained.

As illustrated in Fig. 5-7, `STOP` can be called in the measurement states *RUN* and *STEP*. If called in the *OFF* state the command causes an SCPI error –221, *Settings conflict*.

Sequential execution

`STOP` is implemented as a sequential command. Execution of `STOP` is considered as complete as soon as the measurement state *STOP* is reached.

The `STOP` command causes no events which are set by the event reporting system (see section *Event Reporting* on page 5.29). This means that a service request must be explicitly requested by an `*OPC` command.

`CONTinue:<meas_obj>`

Resumes the measurement for the next measurement evaluation period and changes to the *RUN* state.

As illustrated in Fig. 5-7, `CONTinue` can be called in the measurement states *STOP* and *STEP*. If the previous measurement has been terminated (the measurement status returned by the `FETCh:<meas_obj>:STATus?` is *RDY)*, `CONTinue` restarts the measurement and resets the counters for the evaluation period and statistics (the latter is not used for RF measurements) to zero.

In the other measurement states the command causes an SCPI error –221, *Settings conflict*.

Overlapping execution

`CONTinue` is implemented as an overlapping command like `INITiate`. As a consequence, `*OPC` can not be used together with `CONTinue`.

Stepping mode

The stepping mode determines whether a measurement in the *counting* or *continuous* mode (see section *Measurement Statistics* on page 5.32) is interrupted after each evaluation period (or each statistics cycle, if cycles comprising several evaluation periods are defined) or not. The mode is set via the `<Stepmode>` parameter of the `CONFigure:<meas_obj>:CONTrol:REPetition CONTinuous | 1 ... 10000, <StopCondition>, <Stepmode>` command:

`<Stepmode> = STEP`	The measurement is interrupted (⇒ measurement state *STEP)* after each evaluation period, and the event reporting system (see p. 5.29) is invoked. The next measurement cycle must be started with the `CONTinue:<meas_object>` command.
`<Stepmode> = NONE`	The measurement runs according to its repetition mode. Event reporting is invoked only when the measurement stops (status = RDY).

Note: *STEP can be set in all repetition* modes (single shot, continuous, counting). *For a single shot measurement which is always stopped after one evaluation period, the stepping mode has no effect.*

In function group *RF Non Signalling*, <meas_obj> can stand for any of the measurement objects `POWer and SPECtrum`.

Event Reporting

The event reporting system specifies in which way the CMU reports that a measurement or a measurement step has been correctly terminated, i.e., that the measurement status *STEP* or *RDY* has been reached. Event reporting is configured for each measurement group individually by means of the commands

`CONFigure:<meas_obj>:EREPorting SRQ | SOPC | SRSQ | OFF`

The parameters have the following meaning:

SRQ	Service request. A service request is generated (i.e. bit no. 6 (RQS/MSS) of the status byte (STB) is set) whenever the measurement status *STEP* or *RDY* is reached (see section *Service Request* on page 5.22).
SOPC	Single operation complete. The *operation complete* bit (bit no. 0 in the event status register) is set whenever the measurement status *STEP* or *RDY* is reached (see section *Status Reporting System* on page 5.15).
SRSQ	A service request is generated and the *operation complete* bit is set.
OFF	No special action is taken when the measurement status *STEP* or *RDY* is reached.

Note: *No action is taken if the* STOP *state is reached due to an explicit STOP command.*

Symbolic Measurement Ready Evaluation:

If event reporting is enabled (i.e. `CONFigure:<meas_obj>:EREPorting` is not set to `OFF`), each measurement that reaches the *STEP* or *RDY* status causes an entry in the *measurement queue*. The measurement queue can be queried by means of the `SYSTem:MQUeue[:COMPlete]<spec>?` commands described in chapter 6.

Two different specifiers are provided:

`<spec> = [:LIST]`	Return the complete list of all ready measurements and reset all entries in the measurement queue to *NONE*.
`<spec> = :ITEM`	Return the next ready measurement in the list and reset the corresponding entry in the measurement queue to *NONE*.

Symbolic measurement ready evaluation is in order, e.g. to avoid inconsistencies when a `FETCh...?` command is used to retrieve measurement results (see section Retrieving Measurement Results on page 5.33).

Measurement Status

The status of the current measurement can be queried by means of the following command:

FETCh status `FETCh:<meas_obj>:STATus?`

Return the current status of the measurement. The `FETCh...` command can be used as well to poll the progress of a measurement. The response to the `FETCh...` query has the format `<Status>, <Counting_No>, <Statistic_No>.`

<Status> The first parameter in the response reports on the current status of the measurement. The measurement status returned is closely linked to the four measurement states described in section *Measurement Control Commands and States* on page 5.26 ff.:

OFF	measurement in the *OFF* state after *RST or `ABORt`
RUN	measurement in the *RUN* state after `INITiate`, `CONTinue`, or `READ`
STOP	measurement in the *STOP* state after `STOP` (stopped explicitly)
STEP	measurement in the *STEP* state due to `<Stepmode> = STEP`, valid measurement results
RDY	measurement in the *STOP* state because stopped according to the repetition mode and stop condition set.
ERR	measurement in the *OFF* state because it could not be started with `INITiate` or `READ` for lack of resources, e.g. because the RF connectors were already in use by another measurement.

<Counting_No> The second parameter in the response returns the current value of the statistics counter (the number of the current statistics cycle) if the measurement is performed in the *Counting* mode:

0 ... 10000	number of the current statistics cycle
NONE	no counter for statistics cycles used, i.e. a repetition mode other than *Counting* is set.

<Statistic_No> The third parameter in the response returns the number of the current *evaluation period* (e.g. a burst length in the case of *GSM Power vs Time* or *Modulation* measurements) within a statistics cycle. For *RF Non Signalling* Measurements this counter is not used (response *NONE*).

Generator Control

The commands used for control of the CMU's RF and AF signal generators are analogous to the measurement control commands explained on page 5.26. The generators are in one of the following two generator states:

OFF	generator switched off, resources released
RUN	generator running

The *RUN* state corresponds to the status indication *ON* in the *RF generator* softkey (see section *Analyzer/Generator Menu* in chapter 4).

The relation between generator commands and generator states is shown in the following diagram:

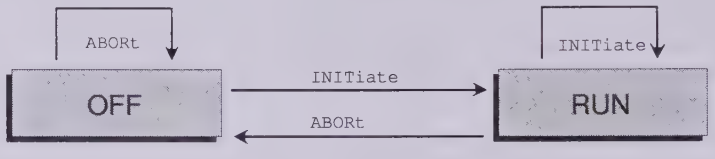


Fig. 5-8 Generator states and control commands

Generator control commands are recognized by the second-level keyword `RFGenerator` or `AFGenerator`. The generator control commands behave as follows:

`INITiate:RFGenerator` **`INITiate:AFGenerator...`**	Starts the generator, reserves all necessary hardware resources and changes to the generator state *RUN.* As illustrated in Fig. 5-8, `INITiate` can be called in any generator state. If the generator is already running *(RUN),* `INITiate` has no effect. If the generator can not be started due to a resources conflict it remains in the *OFF* state, and the measurement status returned by the `FETCh:<meas_obj>:STATus?` is *ERR*. At the same time the SCPI error –213, *Init ignored*, is generated.
Possible resources conflicts	• The RF connector is already allocated by another generator. The other generator must be switched off first.
Sequential execution	`INITiate` is implemented as a sequential command. The `*OPC` command (see chapter 6, *Common Commands)* can be applied together with the `INITiate` command.
`ABORt:RFGenerator` **`ABORt:AFGenerator...`**	Switches the generator off, releases the hardware resources for other generators, and changes to the generator state *RUN.* As illustrated in Fig. 5-8, `ABORt` can be called in any generator state. If the generator is switched off *(OFF),* `ABORt` has no effect.
Sequential execution	`ABORt` is implemented as a sequential command. The command is not terminated before the generator is completely switched off.

Note: *In some measurements (e.g. in function group* Audio), *several RF or AF generators can be used, each of them corresponding to a separate application. In this case, one generator must be switched off (`ABORt:...`) before the application is changed and another generator is started. Otherwise, the measurement will be stopped and the CMU will display an error message.*

Generator Status

The generator status can be queried by means of the `FETCh...?` command:

FETCh command `FETCh:<meas_obj>:STATus?`

Return the current generator status. The `FETCh...` command can be used to poll the generator status. The `FETCh...` query returns one of the following generator states:

OFF	generator is in the *OFF* state (default status after `*RST` or due to `ABORt...` command).
RUN	generator running (*RUN* state after `INITiate...` command).
ERR	generator is in the *OFF* state because it could not be started with an `INITiate...` command for lack of resources (e.g. the RF connector is already in use by another generator).

Measurement Statistics

The *repetition mode* defines how many evaluation periods are measured if the measurement is not stopped explicitly (measurement control commands `STOP...`, `ABORt...`) in the meantime. In case of remote control the three repetition modes *Single Shot, Continuous* and *Counting* are available (*Counting* is not available in manual control, see chapter 3).

Table 5-6 Repetition mode in remote control

Repetition mode	**Description**	**Command**
Single Shot	The measurement is stopped after one evaluation period, i.e., after evaluation of the trace over the whole time/frequency range.	`CONFigure:<meas_obj>:CONTrol:REPetition` **`SINGleshot`**`, <StopCondition>, <Stepmode>` (in RF: `<meas_obj> = POWer | SPECtrum)`
Continuous	The measurement is continued until explicitly stopped. Results are valid after one evaluation period and updated after the next evaluation period has been terminated.	`CONFigure:<meas_obj>:CONTrol:REPetition` **`CONTinuous`**`, <StopCondition>, <Stepmode>` (in RF: `<meas_obj> = POWer | SPECtrum)`
Counting	Repeated single shot measurement with a definite number of evaluation periods. The stepping mode (<Stepmode> = STEP | NONE) determines whether the measurement is stopped after each evaluation period or not, see section *Measurement Control Commands and States* on page 5.26.	`CONFigure:<meas_obj>:CONTrol:REPetition` **`1 ... 10000`**`, <StopCondition>, <Stepmode>` (in RF: `<meas_obj> = POWer | SPECtrum)` (A counting measurement with 1 evaluation period is equivalent to a single shot measurement.)

The statistical evaluation is more refined for the digital network tests, see the relevant operating manuals. In particular, the counting mode is extended by introduction of statistics cycles consisting of an integer number of evaluation periods.

Retrieving Measurement Results

General command structure

The results of a measurement can be retrieved by means of the `FETCh`, `SAMPle` or `READ` query. All three commands have the same structure:

```
FETCh<type>:<meas_obj>[:RESult]<spec>?
SAMPle<type>:<meas_obj>[:RESult]<spec>?
READ<type>:<meas_obj>[:RESult]<spec>?
```

The literals written in angle brackets have the following meaning:

`<type>`	Measurement trace `(:ARRay)`, scalar values `([:SCALar])` can be retrieved in the network tests; see the relevant operating manuals. To limit the number of commands and simplify the program syntax, all scalar results determined in a measurement are generally read out with a single command. They are returned as a list of values separated by commas. The length of the arrays depends on the measurement group and possibly on the configuration settings; see also *Subarrays* paragraph below.
`<meas_obj>`	Measurement group (measurement object): `POWer | SPECtrum` are used in *RF Non Signalling* mode.
`<spec>`	`[:CURRent]` current evaluation period, other statistical traces can be retrieved in the network tests.

Subarrays

Arrays generally consist of a large number of values representing the measurement trace over the whole time or frequency range. With the `SUBarrays` commands, the CMU provides a flexible tool for handling large amounts of data. These commands restrict a measurement to up to 32 subranges where either all measurement results or a single statistical value can be read out.

Subarray configuration

The subarrays are configured with the following commands:

```
CONFigure:SUBarrays:<meas_obj> <Mode>, <Start>, <Samples>
                                        {,<Start>, <Samples>}
```

`<meas_obj>`	Measurement group (measurement object). For examples refer to the manuals for the network tests.
`<Mode>`	Statistics mode for **all** subranges. The following parameters can be set:

`ALL`	Return all measurement values (the number of values in every subrange is given by the `<Samples>` parameter).
`ARIThmetical`	Return the arithmetical mean value of the results in every subrange.
`MINimum`	Return the minimum of the results in every subrange.
`MAXimum`	Return the maximum of the results in every subrange.
`IVAL`	Return a single measurement value corresponding to the abscissa value <Start>. If <Start> is located between two test points with valid results then the result is calculated from the results at these two adjacent test points by linear interpolation. Ignore the <Samples> parameter.

`<Start>`	Start of current range (time or frequency or channel number).

`<Samples>` Number of samples in current range.

The subranges may overlap but must be within the total range of the `<meas_obj>`. Test points outside this range are not measured (result *NAN)* and do not enter into the ARIThmetical, MINimum and MAXimum values.

By default, only one range corresponding to the total measurement range is used and all measurement values are returned.

Subarray results

Subarray results are retrieved by means of `FETCh`, `SAMPle` or `READ` queries, with `:SUBarrays` inserted as a second-level keyword:

```
FETCh:SUBarrays<type>:<meas_obj>[:RESult]<spec>?
SAMPle:SUBarrays<type>:<meas_obj>[:RESult]<spec>?
READ:SUBarrays<type>:<meas_obj>[:RESult]<spec>?
```

In the default subarray configuration, these commands are identical with the `FETCh`, `SAMPle` or `READ` queries described above (i.e. all measurement results are read out).

FETCh command

```
FETCh<type>:<meas_obj>[:RESult]<spec>?
```

Retrieves the latest valid measurement results.

If the `FETCh` query is used immediately after an `INITialize...` command, the first evaluation period is terminated before the query is executed so that a valid result can be acquired. If called up repeatedly after termination of the first evaluation period, the `FETCh` query may return the same results several times until they have been updated after the next period.

A `FETCh` returns the results without interaction with the measurement (unsynchronized query). In some cases this may cause inconsistent results to be read so that the `SAMPle` command should be used while the measurement is in the *RUN* state.

Measurement states

According to the definition given above the effect of the `FETCh` query depends on the measurement status and the history of the measurement:

Status	**Valid Results?**	**Effect of `FETCh...`?**
≠ OFF	Yes	Returns the current results.
OFF	No	Generates an SCPI error –230, *Data corrupt or stale*. This is why `FETCh` should not be used while the measurement is in the *OFF* state.
RUN	No	Waits until valid results are available and returns these results.
STOP	No	Generates an SCPI error –230, *Data corrupt or stale.* This scenario occurs, e.g. if the measurement is stopped explicitly before the first evaluation period has been terminated.

SAMPle command

```
SAMPle<type>:<meas_obj>[:RESult]<spec>?
```

Retrieves the results of the current evaluation period. In single shot measurements, `SAMPle` is equivalent to `READ`.

In a *continuous* measurement, or in *counting* mode (see *repetition mode* in Table 5-6), `SAMPle` is executed only after termination of the current evaluation period. This implies that a single measurement result can be returned only once by a

`SAMPle` query; if called up repeatedly, `SAMPle` will return the result of subsequent evaluation periods.

Due to this behavior, the `SAMPle` query is suitable for monitoring the progress of *continuous* measurements in time. Multiple identical results, which might be returned by repeated `FETCh` commands, are avoided.

A `SAMPle` query returns the results after interacting with the measurement (synchronized query). This means that only valid results are returned, inconsistencies are avoided.

Measurement states According to the definition given above the effect of the `SAMPle` query depends on the measurement status and the history of the measurement:

Status	Valid Results?	Effect of **`SAMPle...?`**
STOP | RDY | STEP	Yes	Returns the current results. In this case, the `SAMPle` command is equivalent to the `FETCh` command.
OFF	No	Generates an SCPI error –230, *Data corrupt or stale*. This is why `SAMPle` should not be used while the measurement is in the *OFF* state.
RUN	Yes | No	Waits until the end of the current evaluation period, returns the results, and resumes the measurement (unless the current evaluation period is the last to be measured).
STOP	No	Generates an SCPI error –230, *Data corrupt or stale*. This scenario occurs, e.g. if the measurement is stopped explicitly before the first evaluation period has been terminated.

READ command

`READ<type>:<meas_obj>[:RESult]<spec>?`

Starts a new measurement, terminates the measurement and returns the results after one single shot. The `READ...?` query is equivalent to:

```
ABORt...;
INITiate...;
FETCh...?
```

The `READ` command preserves all configurations (such as event reporting, stop condition, statistics count...). `READ` initiates a measurement which is terminated after one single shot (⇒ measurement state *STOP*, status *RDY*; if an error occurred, the status is *ERR*). However, it does not affect the repetition mode setting itself.

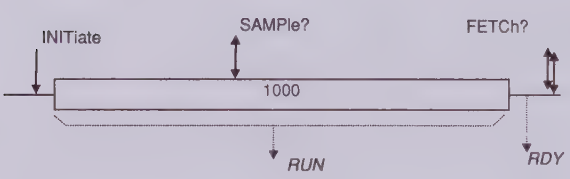
In case of no error (status *RDY*), the measurement can be continued by means of the `CONTinue` command. It will be performed with the repetition mode set before `READ` was executed.

Diagrammatic Overview of Measurement Control

As pointed out in the previous sections the commands used to configure and control the measurements, to query the status of the measurement, and to retrieve the measurement results are closely linked to the settings for the repetition mode and stop condition. The various scenarios are most easily explained by means of a graphical representation of the measurements.

Single Shot Measurements

Stop condition: NONE

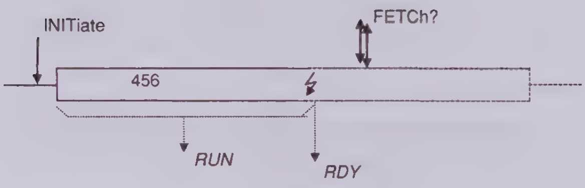


A single shot measurement comprising 1000 evaluation periods with stop condition none is performed. The measurement is started with the `INITiate` command. The results can be queried using the `SAMPle...?` (status *RUN* or *RDY)* or `FETCh...?` (status *RDY)* commands. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type>,1000
CONFigure:<meas_obj>:CONTrol:REPetition
       SINGleshot,NONE,<Stepmode>
```

The <Stepmode> parameter has no effect.

Stop condition: SONerror



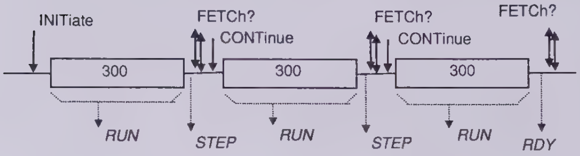
A single shot measurement comprising 1000 evaluation periods with stop condition SONerror is performed. The measurement is started with the `INITiate` command and stopped before the end of the statistics cycle. The results can be queried using the `SAMPle...?` (status *RUN* or *STOP)* or `FETCh` (status *STOP)* commands. The number of bursts measured can be queried using the `FETCh:<meas_obj>:STATus?` command. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type>,1000
CONFigure:<meas_obj>:CONTrol:REPetition
                    SINGleshot,SONerror
                    <Stepmode>
```

The <Stepmode> parameter has no effect.

Counting Measurements

Stop condition: NONE

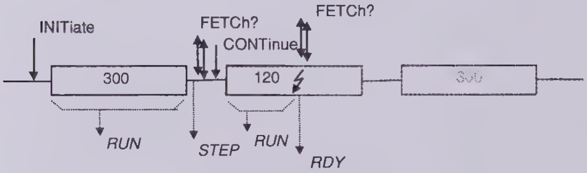


A counting measurement comprising 3 counts of measurements, each about a statistics cycle of 300 evaluation periods, is performed. The measurement is started with the `INITiate` command. The results can be queried using the `SAMPle...?` (status *RUN, STEP* or *RDY)* or `FETCh...?` (status *STEP* or *RDY)* commands. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type>,300
CONFigure:<meas_obj>:CONTrol:REPetition
                         3,NONE,<Stepmode>
```

The STEP status occurs only if the stepping mode is set (`<Stepmode> = STEP`). In this case, the next cycle must be restarted via the `CONTinue` command.

Stop condition: SONerror



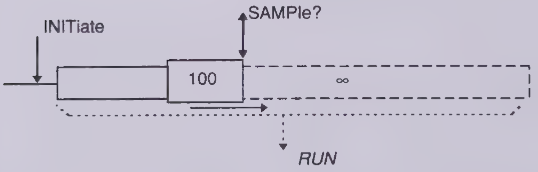
A counting measurement comprising counts of measurements, each about a statistics cycle of 300 evaluation periods, is performed. The measurement is started with the `INITiate` command. The results can be queried using the `SAMPle...?` (status *RUN, STEP* or *RDY)* or `FETCh...?` (status *STEP* or *RDY)* commands. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type>,300
CONFigure:<meas_obj>:CONTrol:REPetition
                         3,SONerror,<Stepmode>
```

The STEP status occurs only if the stepping mode is set (`<Stepmode> = STEP`). In this case, the next cycle must be restarted via the `CONTinue` command.

Continuous Measurements

Statistics cycles, stop condition: NONE

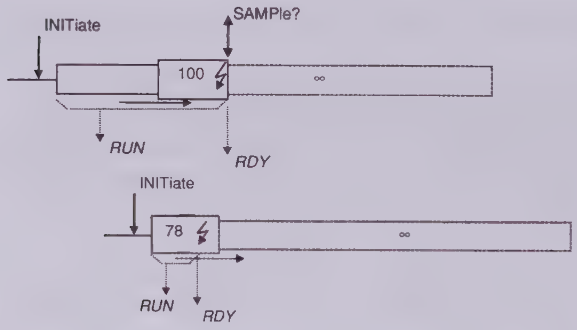


A continuous measurement with statistics cycles consisting of 100 bursts each is performed. The window used for evaluating average values is continuously shifted, comprising the latest 100 evaluation periods. The measurement is started with the `INITiate` command. Results can be queried using the `SAMPle...?` command (status *RUN)*. During the measurement `FETCh...?` may return inconsistent results. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type> 100
CONFigure:<meas_obj>:CONTrol:REPetition
                   CONTinuous,NONE,NONE
```

Statistics cycles, stop condition: SONerror

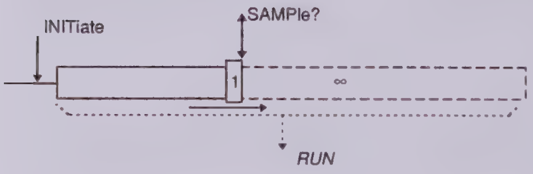
A continuous measurement with statistics cycles consisting of 100 evaluation periods each is performed. The measurement is started with the `INITiate` command. Results can be queried the `SAMPle...?` command (status *RUN, STOP)*. During the measurement `FETCh...?` may return



inconsistent results. If the stop condition is met during the first statistics cycle no valid result is available. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type> 100
CONFigure:<meas_obj>:CONTrol:REPetition
                   CONTinuous,SONerror,NONE
```

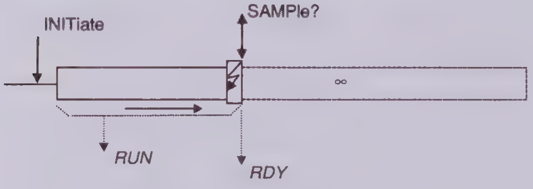
Statistics off, stop condition: NONE



A continuous measurement is performed. No statistics cycles are defined. The measurement is started with the `INITiate` command. Results can be queried using the `SAMPle...?` command (status *RUN).* During the measurement `FETCh...?` may return inconsistent results. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type> OFF
CONFigure:<meas_obj>:CONTrol:REPetition
                   CONTinuous,NONE,NONE
```

Statistics off, stop condition: SONerror



A continuous measurement is performed. No statistics cycles are defined. The measurement is started with the `INITiate` command. Results can be queried the `SAMPle...?` command (status *RUN, STOP).* During the measurement `FETCh...?` may return inconsistent results. The measurement is configured via:

```
CONFigure:<meas_obj>:CONTrol <type> OFF
CONFigure:<meas_obj>:CONTrol:REPetition
                   CONTinuous,SONerror,NONE
```

Note: *The* stepping *mode can be set for continuous measurements as well (Parameter `<Stepmode>=STEP`, see section* Counting Measurements *on page 5.37). In this case, the system takes up the STEP status after each statistics cycle. It can be relaunched via the `CONTinue` command.*

Special Terms and Notation

Below we list some particular features in the syntax of the remote control commands. The general description of the SCPI command syntax can be found in section *Structure and Syntax of Device Messages* on page 5.6.

Description of commands

The commands are arranged in tables; all of them are arranged in the same way. From top to bottom, the table rows contain the following entries:

1. Complete command syntax including the parameter list and a short description of the command,
2. List and description of the parameters with their default values, the units, and unit rings.
3. Detailed description of the command, signalling state required for command execution, required firmware version.

Extensive lists of default values are annexed to the command description.

Order of commands

The commands are arranged according to their function. The general purpose of a command is described by the keyword in the second level. Lower-level keywords define the command in more detail. This means that commands with the same second-level, third-level etc. keywords are generally grouped together in the same sections.

Example:

```
CONFigure:POWer:MARKer:REFerence:POSition
                           <Position>
```

Commands with the keyword *POWer* in the second level belong to the power measurement. The keywords in the third, fourth and fifth level indicate that the command defines the position of the reference marker used in the power measurement.

Measurement object

The term *measurement object* denotes a group of remote control commands relating to the same group of measured quantities. E.g., all commands concerning the measurement of the signal power vs time form a common measurement object.

Combined measurements

To limit the number of remote control command and their parameters, scalar quantities of the same measurement object are always measured together and returned in lists.

Parameters

Many commands are supplemented by a parameter or a list of parameters. Parameters either provide alternative options (setting a or setting b or setting c ..., see special character "|"), or they form a list separated by commas (setting x,y).

<Par_Name>

In the command tables and lists, parameters are generally described by a name (literal) written in angle brackets (<>). This literal merely serves as a parameters description; in an application program it must be replaced by one of the possible settings reported in the detailed parameter description.

Example: `CONFigure:POWer:CONTrol <Mode>,<Statistics>`

with `<Mode>` = `SCALar | ARRay`
`<Statistics>` = `1 to 10000 | NONE`

possible command syntax: `CONF:POW:CONT SCAL,OFF`

NAN NAN (not a number) is generally used to represent missing data, e.g. if a portion of a trace has not been acquired yet. It is also returned after invalid mathematical operations such as division by zero. As defined in the SCPI standard, NAN is represented as 9.91 E 37.

INV INV (invalid) is returned if a limit check is performed without defining the appropriate tolerance values.

Upper / lower case

Upper/lower case characters characterize the long and short form of the keywords in a command. The short form consists of all upper-case characters, the long form of all upper case plus all lower case characters. On the CMU, either the short form or the long form are allowed; mixed forms will generally not be recognized. Either the short form or the long form are permissible. The instrument itself does not distinguish upper case and lower case characters.

Special characters

| A vertical stroke in the parameter list characterizes alternative parameter settings. Only one of the parameters separated by | must be selected.

Example: The following command has two alternative settings:

```
TRIGger:SEQuence:DEFault ON | OFF
```

[ ] *Key words* in square brackets can be omitted when composing the command header (see chapter 5 of the CMU manual, section "Structure of a Command"). The complete command must be recognized by the instrument for reasons of compatibility with the SCPI standard.
Parameters in square brackets are optional as well. They may be entered in the command or omitted.

{ } Braces or curly brackets enclose one or more parameters that may be included zero or more times.

<nr> This symbol stands for a numeric suffix, e.g. an enumeration index for input and output connectors.

Lists of commands

Command: The *Command* column of the table contains all remote control commands arranged according to their function (configurations or measurement objects). Within a section, the commands are listed in alphabetical order.

Parameters: The *Parameter* column lists the parameters of the commands.

Remarks: The *Remarks* column gives additional information about the commands which

- Have no query form *(no query)*
- Have only a query form *(query only)*
- Can be used both as setting commands and as queries (*with query*, this applies to all commands belonging to none of the two preceding categories)

Alphabetical Lists Chapter 6 concludes with alphabetical command lists for both test modes.

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6 Remote Control – Commands

In the following, all remote-control commands for the *Base* system and the function groups *RF Non Signalling* and *Audio* will be presented in tabular form with their parameters and the ranges of numerical values. The chapter is organized as follows:

- Common commands, commands for the base system and the function groups *RF Non Signalling* and *Audio* are presented separately.
- Within the measurement modes, first the general configuration and then the individual measurement groups (measurement objects) are dealt with.

An introduction to remote control according to the SCPI standard, the status registers of the CMU, and the operating concept and measurement control is given in chapter 5.

Common Commands

The common commands are taken from the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect on different devices. The headers of these commands consist of "*" followed by three letters. Many common commands refer to the status reporting system which is described in detail in chapter 5.

Table 6-1 Common Commands

Command	**Parameters**	**Remark**
***CLS**		no query
***ESE**	0 to 255	
***ESR?**		query only
***IDN?**		query only
***IST?**		query only
***OPC**		
***OPT?**		query only
***PRE**	0 to 255	
***PSC**	0 | 1	
***RST**		no query
***SEC**	0 to 30	No common command; see p. 6.13
***SRE**	0 to 255	
***STB?**		query only
***TST?**		query only
***WAI**		

***CLS**

CLEAR STATUS sets the status byte (STB), the standard event register (ESR) and the EVENt-part of the QUEStionable and the OPERation register to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

***ESE** 0 to 255

EVENT STATUS ENABLE sets the event status enable register to the value indicated. Query *ESE? returns the contents of the event status enable register in decimal form.

***ESR?**

STANDARD EVENT STATUS QUERY returns the contents of the event status register in decimal form (0 to 255) and subsequently sets the register to zero.

***IDN?**

IDENTIFICATION QUERY queries the instrument identification.

***IST?**

INDIVIDUAL STATUS QUERY returns the contents of the IST flag in decimal form (0 | 1). The IST-flag is the status bit which is sent during a parallel poll (see chapter 5).

***OPC**

OPERATION COMPLETE sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request (cf. chapter 5).

***OPC?**

OPERATION COMPLETE QUERY writes message "1" into the output buffer as soon as all preceding commands have been executed (cf. chapter 5).

***OPT?**

OPTION IDENTIFICATION QUERY queries the options included in the instrument and returns a list of the options installed. The response consists of Arbitrary ASCII Response Data according to IEEE 488.2. The options are separated from each other by commas and have fixed positions in the output string. A zero is returned for options that are not installed.

Example:

```
0,K20,K21,K22,K23,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,B11,B21,B41,B52,0,0,B62,0,0,0,0
,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,FMR5,64 MB,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
0,rxtx1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

An alternative list of options can be queried via the command SYSTem:OPTions?

The CMU software options are listed in positions 0 to 29 of the output string:

Position	Response	Description	Position	Response	Description
0	K0	DemoPack	15	K41	EDGE
1	K20	GSM400-MS	16	K53	Bluetooth
2	K21	GSM900-MS	17	K65	WCDMA TX Measurements
3	K22	GSM1800-MS	18	K81	CDMA1-MS 800
4	K23	GSM1900-MS	19	K82	CDMA1-MS 1700/1900
5	K24	GSM850-MS	20	K83	CDMA2000 450
6	K27	IS 136-800-MS	21	K84	CDMA2000 800
7	K28	IS 136-1900-MS	22	K85	CDMA2000 1700/1900
8	K29	AMPS-MS	23	K86	CDMA2000 2200
9	K30	GSM400-BS	24	0	not used

Position	Response	Description	Position	Response	Description
10	K31	GSM900-BS	25	0	not used
11	K32	GSM1800-BS	26	0	not used
12	K33	GSM1900-BS	27	0	not used
13	K34	GSM850-BS	28	0	not used
14	K39	MOC/MTC for GSM-BS	29	0	not used

The CMU hardware options are listed in positions 30 to 59 of the output string:

Position	Response	Description	Position	Response	Description
30	CMU-B11/B12	OCXO	45	0	not used
31	CMU-B21	Universal Signalling Unit	46	0	not used
32	CMU-B41	Audio option	47	0	not used
33	CMU-B52	Speech coder for CMU-B21	48	0	not used
34	CMU-U61	Floppy disk drive	49	0	not used
35	CMU-U65/1 DDC400	DDC400 for WCDMA	50	0	not used
36	CMU-B62	PCMCIA	51	0	not used
37	CMU-B53	Bluetooth	52	0	not used
38	CMU-B71	ABIS	53	0	not used
39	CMU-B81	CDMA LH	54	0	not used
40	CMU-B83	CDMA2000 LH	55	0	not used
41	0	not used	56	0	not used
42	0	not used	57	0	not used
43	0	not used	58	0	not used
44	0	not used	59	0	not used

The CMU equipment options are listed in positions 60 to 79 of the output string:

Position	Response	Description	Position	Response	Description
60	CPU	–	70	0	not used
61	MEMORY	–	71	0	not used
62	0	not used	72	0	not used
66	0	not used	73	0	not used
64	0	not used	74	0	not used
65	0	not used	75	0	not used
66	0	not used	76	0	not used
67	0	not used	77	0	not used
68	0	not used	78	0	not used
69	0	not used	79	0	not used

The CMU hardware equipment is listed in positions 80 to 109 of the output string:

Position	Response	Description	Position	Response	Description
80	rxtx1	RXTX board 1	910	0	not used
81	0	not used	96	0	not used
82	0	not used	97	0	not used
88	0	not used	98	0	not used
89	0	not used	99	0	not used
85	0	not used	100	0	not used
86	0	not used	101	0	not used
87	0	not used	102	0	not used

Position	Response	Description
88	0	not used
89	0	not used
90	0	not used
91	0	not used
92	0	not used
98	0	not used
99	0	not used
103	0	not used
104	0	not used
105	0	not used
106	0	not used
107	0	not used
108	0	not used
109	0	not used

***PRE 0 to 255**

PARALLEL POLL REGISTER ENABLE sets parallel poll enable register to the value indicated. Query *PRE? returns the contents of the parallel poll enable register in decimal form.

***PSC 0 | 1**

POWER ON STATUS CLEAR determines whether the contents of the ENABle registers is maintained or reset in switching on.

*PSC = 0	causes the contents of the status registers to be maintained. Thus a service request can be triggered in switching on in the case of a corresponding configuration of status registers ESE and SRE.
*PSC ≠ 0	resets the registers.

Query *PSC? reads out the contents of the power-on-status-clear flag. The response can be 0 or 1.

***RST**

RESET sets the instrument to a defined default status. The command essentially corresponds to pressing the [RESET] key. The default setting is indicated in the description of commands.

***SRE 0 to 255**

SERVICE REQUEST ENABLE sets the service request enable register to the value indicated. Bit 6 (MSS mask bit) remains 0. This command determines under which conditions a service request is triggered. Query *SRE? reads the contents of the service request enable register in decimal form. Bit 6 is always 0.

***STB?**

READ STATUS BYTE QUERY reads the contents of the status byte in decimal form.

***TST?**

SELF TEST QUERY triggers selftests of the instrument and outputs an error code in decimal form (the output is zero in the current firmware version).

***WAI**

WAIT-to-CONTINUE only permits the servicing of the subsequent commands after all preceding commands have been executed and all signals have settled (see also chapter 5 and "*OPC").

CMU Base System

System Commands

The SYSTem subsystem contains the functions that are not related to instrument performance. The CMU supports the following SCPI-confirmed SYSTem commands:

SYSTem:ERRor?				Error Queue
Response	Parameter description	Def. value	Default unit	Unit ring
-32768 to +32768 and error string **Ex.: -230,"Data corrupt or stale"**	Error message	0, "No error"	–	
Command description				FW vers.
This command queries the next entry from the error/event queue and deletes it. Positive error numbers are instrument-dependent; negative error numbers are reserved by the SCPI standard, see chapter 9. If the error queue is empty, the error number 0, "No error" is returned.				≥ V 1.20

SYSTem:VERSion?				SCPI Version
Response	Parameter description	Def. value	Default unit	Unit ring
YYYY.V **Ex.: 1990.0**	SCPI version of CMU	–	–	
Command description				FW vers.
This command queries the SCPI version number for which the instrument complies. YYYY is the year of SCPI compliance, V is the version number within the year.				≥ V 1.20

SYSTem:NONVolatile:DISable	Disable Nonvolatile RAM
Command description	FW vers.
This command has no query form. It prevents the CMU from saving measurement settings to the nonvolatile RAM. This improves the system performance but implies that the current settings will not be saved for later sessions. **Note:** *There is no way to cancel the effect of the `SYSTem:NONVolatile:DISable` command within the current session, even is the CMU is switched to manual control (Local). To re-enable the nonvolatile RAM, the CMU must be rebooted.*	≥ V 3.0

Status Commands

The STATus subsystem controls the SCPI-defined status reporting structures. The purpose and definition of status registers is given in chapter 5, section "Status Reporting System". Unless otherwise stated, all the following commands are SCPI-confirmed.

STATus:OPERation[:EVENt]?				Event Part
Response	Parameter description	Def. value[1]	Default unit	Unit ring
0 to 32767	Event part	–	–	
Command description				FW vers.
This command queries and deletes the contents of the EVENt part of the STATus:OPERation register.				≥ V 1.20

STATus:OPERation:CONDition?				CONDition part
Response	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Condition part	–	–	
Command description				FW vers.
This command queries the contents of the CONDition part of the STATus:OPERation register. Reading this register is nondestructive.				≥ V 1.20

STATus:OPERation:PTRansition *<Number>*				Positive transition
<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Positive transition part	–	–	
Command description				FW vers.
This command enters a number to be interpreted as a bit pattern in the PTRansition part of the STATus:OPERation register. If a bit is set the corresponding 0-to-1 transition in the CONDition part (indicating that an event in the hardware occurred) is entered into the EVENt part.				≥ V 1.20

STATus:OPERation:NTRansition *<Number>*				Negative transition
<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Negative transition part	–	–	
Command description				FW vers.
This command enters a number to be interpreted as a bit pattern in the NTRansition part of the STATus:OPERation register. If a bit is set the corresponding 1-to-0 transition in the CONDition part (indicating that an event in the hardware disappeared) is entered into the EVENt part.				≥ V 1.20

---

[1] `*RST` does not supersede the entries in the status registers; for an overview of the reset values of the `STATus...` system refer to section *Reset Values of the Status Reporting Systems* in chapter 5.

STATus:OPERation:ENABle *<Number>*				Enable part
<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Enable part	–	–	
Command description				FW vers.
This command enters a number to be interpreted as a bit pattern in the ENABle part of the STATus:OPERation register. If a bit is set the corresponding event is reported in the summary bit of the status byte.				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>[:EVENt]?				Event part
Response	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Event part	–	–	
Command description				FW vers.
This command queries and deletes the contents of the EVENt part of the STATus:OPERation:CMU:SUM<nr> register (<nr> = 1,2).				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>:CONDition?				CONDition part
Response	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Condition part	–	–	
Command description				FW vers.
This command queries the contents of the CONDition part of the STATus:OPERation:CMU:SUM<nr> register (<nr> = 1,2). Reading this register is nondestructive.				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>:PTRansition *<Number>*				Positive transition
<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Positive transition part	–	–	
Command description				FW vers.
This command enters a number to be interpreted as a bit pattern in the PTRansition part of the STATus:OPERation:CMU:SUM<nr> register (<nr> = 1,2). If a bit is set the corresponding 0-to-1 transition in the CONDition part (indicating that an event in the hardware occurred) is entered into the EVENt part.				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>:NTRansition *<Number>*				Negative transition
<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Negative transition part	–	–	
Command description				FW vers.
This command enters a number to be interpreted as a bit pattern in the NTRansition part of the STATus:OPERation:CMU:SUM<nr> register (<nr> = 1,2). If a bit is set the corresponding 1-to-0 transition in the CONDition part (indicating that an event in the hardware disappeared) is entered into the EVENt part.				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>:ENABle *<Number>*				Enable part
<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Enable part	–	–	
Command description				FW vers.
This command enters a number to be interpreted as a bit pattern in the ENABle part of the STATus:OPERation:CMU:SUM<nr> register (<nr> = 1,2). If a bit is set the corresponding event is reported in the summary bit of the status byte.				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>[:EVENt]?				Event part
Response	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Event part	–	–	–
Command description				FW vers.
This command queries and deletes the contents of the EVENt part of the STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> register (<nr> = 1 to 2; <nr_event> = 1 to 15).				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:CONDition?				CONDition part
Response	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Condition part	–	–	
Command description				FW vers.
This command queries the contents of the CONDition part of the STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> register (<nr> = 1 to 2; <nr_event> = 1 to 15). Reading this register is nondestructive.				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:PTRansition *<Number>*				Positive transition
<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Positive transition part	–	–	
Command description				FW vers.
This command enters a number to be interpreted as a bit pattern in the PTRansition part of the STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> register (<nr> = 1 to 2; <nr_event> = 1 to 15). If a bit is set the corresponding 0-to-1 transition in the CONDition part (indicating that an event in the hardware occurred) is entered into the EVENt part.				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:NTRansition *<Number>*				Negative transition
<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Negative transition part	–	–	
Command description				FW vers.
This command enters a number to be interpreted as a bit pattern in the NTRansition part of the STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> register (<nr> = 1 to 2; <nr_event> = 1 to 15). If a bit is set the corresponding 1-to-0 transition in the CONDition part (indicating that an event in the hardware disappeared) is entered into the EVENt part.				≥ V 1.20

STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:ENABle *<Number>* Enable part

<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Enable part	–	–	

Command description	FW vers.
This command enters a number to be interpreted as a bit pattern in the ENABle part of the STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> register (<nr> = 1 to 2; <nr_event> = 1 to 15). If a bit is set the corresponding event is reported in the summary bit of the status byte.	≥ V 1.20

STATus:OPERation:CMU:ALL? Query all operation registers

Response	Parameter description	Def. value	Default unit	Unit ring
0 to 32767, ... , 0 to 32767	Event part of all CMU operation registers	–	–	

Command description	FW vers.
This command queries the EVENt parts of all STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> registers. The result is returned as a list of 30 integer values separated by commas.	≥ V 1.20

STATus:OPERation:CMU:CLEar Clear all operation registers

Command description	FW vers.
This command clears the EVENt parts of all STATus:OPERation:CMU:SUM<nr>:CMU<nr_event> registers (<nr> = 1 to 2; <nr_event> = 1 to 15).	≥ V 1.20

STATus:QUEStionable[:EVENt]? Event part

Response	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Event part	–	–	

Command description	FW vers.
This command queries and deletes the contents of the EVENt part of the STATus:QUEStionable register.	≥ V 1.20

STATus:QUEStionable:CONDition? CONDition part

Response	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Condition part	–	–	

Command description	FW vers.
This command queries the contents of the CONDition part of the STATus:QUEStionable register. Reading this register is nondestructive.	≥ V 1.20

STATus:QUEStionable:PTRansition *<Number>* Positive transition

<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Positive transition part	–	–	

Command description	FW vers.
This command enters a number to be interpreted as a bit pattern in the PTRansition part of the STATus:QUEStionable register. If a bit is set the corresponding 0-to-1 transition in the CONDition part (indicating that an event in the hardware occurred) is entered into the EVENt part.	≥ V 1.20

STATus:QUEStionable:NTRansition *<Number>* Negative transition

<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Negative transition part	–	–	

Command description	FW vers.
This command enters a number to be interpreted as a bit pattern in the NTRansition part of the STATus:QUEStionable register. If a bit is set the corresponding 1-to-0 transition in the CONDition part (indicating that an event in the hardware disappeared) is entered into the EVENt part.	≥ V 1.20

STATus:QUEStionable:ENABle *<Number>* Enable part

<Number>	Parameter description	Def. value	Default unit	Unit ring
0 to 32767	Enable part	–	–	

Command description	FW vers.
This command enters a number to be interpreted as a bit pattern in the ENABle part of the STATus:QUEStionable register. If a bit is set the corresponding event is reported in the summary bit of the status byte.	≥ V 1.20

STATus:PRESet Reset status registers

Command description	FW vers.
This command sets the edge detectors (PTRansition and NTRansition parts) and the ENABle registers of the STATus:OPERation and the STATus:QUEStionable registers to defined values: • PTRansition is set to 32767 (0x7FFF), i.e. all hardware events are detected and transferred to the EVENt register. • NTRansition is set to 0, i.e. a hardware event that disappears does not cause any change in the EVENt register. The ENABle registers are also set to 0 so that events are not reported in the status byte.	≥ V 1.20

Symbolic Status Event Register Evaluation

The following commands are used to retrieve the events reported and the corresponding function groups; see section *Symbolic Status Event Register Evaluation* in chapter 5.

STATus:OPERation:EVENt:SADDress? Symbolic status evaluation

Response	Parameter description	Def. Value[2]	Default Unit	Unit Ring
1 to 30, **"Fgrp"**	"Next" secondary address Corresponding function group name (or "", if no event was reported)	31 ""	– –	

Command description	FW vers.
This command is always a query. It checks the `STATus:OPERation:CMU:SUM<nr>:EVENt` sum registers (<nr> = 1 | 2), returns the next secondary address and function group string where an event was reported, and deletes the entry in the `EVENt` register. If applied repeatedly, the command checks the secondary addresses in ascending order (i.e. the events are not queried chronologically). The command is global; it is available in all function groups. Possible responses are: *1,"RF_NSig"* An event was reported in function group *RF Non Signalling* (currently assigned to secondary address 1). *31,""* No (further) event reported.	≥ V2.10

STATus:OPERation:SYMBolic:ENABle <Event>{,<Event>} Symbolic status evaluation

Parameter list	Parameter description	Def. Value[3]	Default Unit	Unit Ring
<Event>{,<Event>} | **NONE**	List of symbols for events to be reported No event reported	NONE	–	

Command description	FW vers.
This command enables event reporting for one or several events in the current function group, ie. it sets the corresponding bits in the `STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:ENABle` register (`<nr> = 1 | 2, <nr_event>` denotes the current function group) and in all sum registers up to the status byte. The events and the corresponding symbols for each function group are listed in chapter 5 of the relevant manuals (see section *Status Registers).* The symbols may be entered in arbitrary order.	≥ V2.10

STATus:OPERation:SYMBolic[:EVENt]? Symbolic status evaluation

Response	Parameter description	Def. Value[4]	Default Unit	Unit Ring
NONE | **<Event>{,<Event>}**	No event in the current function group List of reported events	NONE	–	

Command description	FW vers.
This command is always a query. It lists the events reported in the current function groups and deletes these events in the `STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:EVENt` register as well as in all sum registers.	≥ V2.10

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[2] The default values quoted in this command are achieved after a `*CLS` command. `*RST` does not supersede the entries in the status registers; see section *Reset Values of the Status Reporting Systems* in chapter 5.

[3] The default values quoted in this command are achieved after a `STATus:PRESet` command. `*RST` does not supersede the entries in the status registers; see section *Reset Values of the Status Reporting Systems* in chapter 5.

[4] The default values quoted in this command are achieved after a `*CLS` command. `*RST` does not supersede the entries in the status registers; see section *Reset Values of the Status Reporting Systems* in chapter 5.

Setup – Basic Device Settings

The SETup subsystem contains the commands for global configuration of the remote control parameters, the serial interfaces, the options, date and time, the keyboard and beeper. It corresponds to the *Setup* menu opened via the *SETUP* key on the front panel.

Subsystem Remote

The *REMote* subsystem contains the commands for configuration of the remote control parameters. It corresponds to the *Remote* tab in the *Setup* menu opened via the *SETUP* key on the front panel.

SYSTem:REMote:ADDRess:PRIMary *<Addr>* Primary Address

<Addr>	Parameter description	Def. value	Default unit	Unit ring
0 to 30	Primary address to the GPIB (IEEE) bus	20	–	

Command description	FW vers.
This command sets the primary address of the GPIB driver which is used to address the device (CMU). It is equivalent to `SYSTem:COMMunicate:GPIB[:SELF]:ADDRess` (see below).	≥ V 1.20

SYSTem:REMote:ADDRess:SECondary *<Addr>,<FGrp>* Secondary Address

<Addr>,<FGrp>	Parameter description	Def. value	Default unit	Unit ring
1 to 29, „FGrp_name" | NONe	Secondary address of the GPIB bus Name of the function group or NONE if the secondary address is not to be mapped	Configuration specific	–	

Command description	FW vers.
This command assigns the secondary addresses to the remote control modes (function groups) of the GPIB driver (compare next command). If a secondary address is successively assigned to different function groups, the previous assignments are overwritten. The function group names are quoted below or at the beginning of chapter 5 of each network test manual; some examples are:	≥ V 1.17

FGrp_name	**Function Group**	**FGrp_name**	**Function Group**
BASE	CMU base system	Audio_NSig	Audio Generator and Analyzer
RF_NSig	RF Non Signalling	IS136800MS_NSig	TDMA800-MS Non Signalling
GSM900MS_NSig	GSM900-MS Non Signalling	IS136800MS_Sig	TDMA800-MS Signalling
GSM900MS_Sig	GSM900-MS Signalling	IS1361900MS_NSig	TDMA1900-MS Non Signalling
GSM1800MS_NSig	GSM1800-MS Non Signalling	IS1361900MS_NSig	TDMA1900-MS Signalling
GSM1800MS_Sig	GSM1800-MS Signalling	AMPSMS_NSig	AMPS-MS Non Signalling
GSM1900MS_NSig	GSM1900-MS Non Signalling	AMPSMS_Sig	AMPS-MS Signalling

The CMU base system (function group *BASE)* is always assigned to secondary address 0; the assignment cannot be changed by the `SYSTem:REMote:ADDRess:SECondary` command. A program example illustrating how to adapt the secondary addresses to the requirements of a specific driver can be found in chapter 7.

Example:	Setting:	SYST:REM:ADDR:SEC 2,"GSM900MS_NSig" SYST:REM:ADDR:SEC 1,NONE
	Query: --> Response:	SYST:REM:ADDR:SEC? 2 "GSM900MS_NSig"
	Query: --> Response:	SYST:REM:ADDR:SEC? 1 NONE
	Query: --> Response:	SYST:REM:ADDR:SEC? NONE,"GSM900MS_NSig", ... (30 returned values)

*SEC <Addr>				Secondary Address
<Addr>	Parameter description	Def. value	Default unit	Unit ring
0 to 30	Secondary address	0	–	
Command description				FW vers.
This command has no query form. It switches over to the specified secondary address. It is required if the serial interface is used for remote control (software switchover, RS-232 remote interface, see previous command and section *Setting the Device Address* in chapter 5).				≥ V 1.20

Subsystem Communicate

The *COMMunicate* subsystem contains the commands for configuration of the remote serial interfaces. It corresponds to the *Communicate* tab in the *Setup* menu opened via the *SETUP* key on the front panel. The parameters set in this subsystem are explained in more detail in chapter 8, section *Hardware Interfaces*.

SYSTem:COMMunicate:GPIB[:SELF]:ADDRess *<Addr>*				Primary Address
<Addr>	Parameter description	Def. value	Default unit	Unit ring
0 to 30	Primary address to the GPIB (IEEE) bus	20	–	
Command description				FW vers.
This command sets the primary address of the GPIB driver which is used to address the device (CMU). It is equivalent to `SYSTem:REMote:ADDRess:PRIMary` (see above).				≥ V 1.20

SYSTem:COMMunicate:SERial<1|2>:APPLication?				Application
Response	Parameter description	Def. value	Default unit	Unit ring
TRAN | **REM |** **PRIN**	Transfer Remote control Printer control (future extension)	dep. on SCPI connection (port) and printer settings	-	
Command description				FW vers.
This command is always a query. It returns the current application (connection) of the serial (RS-232) interface. The numeric suffix distinguishes the two interfaces COM1 and COM2.				≥ V 1.20

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD *<Baudrate>*				Baud Rate
<Baudrate>	Parameter description	Def. value	Default unit	Unit ring
110 | 300 | 600 | 1200 | 2400 | 4800 | 9600 | 19200	baud rate	9600	–	
Command description				FW vers.
This command sets the baud rate of the serial interface no. 1 or 2 (connectors COM 1 or COM 2).				≥ V 1.20

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITs *<DataBits>*				Data Bits
<DataBits>	Parameter description	Def. value	Default unit	Unit ring
7 | 8	number of data bits	8	–	
Command description				FW vers.
This command sets the number of data bits of the serial interface no. 1 or 2 (connectors COM 1 or COM 2). The sum of data bits and stop bits must be equal to 9.				≥ V 1.20

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:STOP *<StopBits>*				Stop bits
<StopBits>	Parameter description	Def. value	Default unit	Unit ring
1 | 2	number of stop bits	1	-	
Command description				FW vers.
This command sets the number of stop bits of the serial interface no. 1 or 2 (connectors COM 1 or COM 2). The sum of data bits and stop bits must be equal to 9.				≥ V 1.20

SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PARity[:TYPE] *<Parity>*				Parity
<Parity>	Parameter description	Def. value	Default unit	Unit ring
NONE	no parity	NONE	–	
ODD	odd parity			
EVEN	even parity			
Command description				FW vers.
This command sets the parity of the serial interface no. 1 or 2 (connectors COM 1 or COM 2).				≥ V 1.20

SYSTem:COMMunicate:SERial<1|2>:TRANsmit:PACE *<Pace>*				Transmission Protocol
<Pace>	Parameter description	Def. value	Default unit	Unit ring
XON	Xon/Xoff – protocol	XON	–	
ACK	Hardware protocol with CTS/RTS lines			
NONE	No protocol set			
Command description				FW vers.
This command sets the handshake protocol of the serial interface no. 1 or 2 (connectors COM 1 or COM 2).				≥ V 1.20

Subsystem Options

The *Options* subsystem contains the commands for querying information on the instrument and the available options. It corresponds to the *Options* tab in the *Setup* menu opened via the *SETUP* key on the front panel.

SYSTem:OPTions:INFo?			Device Info
Response	Def. value	Default unit	Unit ring
Example: ROHDE&SCHWARZ,CMU 200,840675/018,V1.17B 1998-11-30	–	–	
Command description			FW vers.
This command returns the information on the device comprising the manufacturer, model, serial number and firmware version. This command is always a query and is equivalent to the common command `*IDN?`			≥ V 1.20

SYSTem:OPTions? Options

Response	Parameter description	Def. value	Default unit	Unit ring
HWO, "B11/B12","01.00", "B2",NAN, ... ,	Identifier for hardware options 1st option, 2nd option, 3, 4 ...	–	–	
SWO, "K1","1.07", "K2",NAN, ... ,	Identifier for software options 1st Option, 2nd Option, 3, 4 ...			
HWE, "CPU(FMR)", "01" ...	Identifier for hardware equipment 1st equipment, 2nd equipment, 3, 4 ...			
FWV, „uP1","01.00", ...	Identifier for firmware versions 1st Option, 2nd Option, 3, 4 ...			

Command description	FW vers.
This command returns a list of all options and equipment available in the instrument. It is always a query. An alternative list of options (following IEEE 488.2 conventions) can be queried via the common command *OPT?	≥ V 1.20

Subsystem Time

The *Time* subsystem contains the commands for the current time and date. It corresponds to the *Time* tab in the *Setup* menu opened via the *SETUP* key on the front panel.

SYSTem:TZONe *<Hour>[,<Minute>]* or
SYSTem:TIMe:TZONe *<Hour>[,<Minute>]* Time Zone

Parameters	Parameter description	Def. value	Default unit	Unit ring
<Hour> <Minute>	integer value between –12 and +12 -59 to +59 (optional)	+1 0	–	

Command description	FW vers.
This command defines the time zone via the time offset from Greenwich mean time. A time offset of +1 h (default setting) corresponds to Middle European time.	≥ V 1.20

SYSTem:TIMe[:TIMe] *<Hour>,<Minute>,<Second>* or
SYSTem:TIMe *<Hour>,<Minute>,<Second>* Current Time

Parameters	Parameter description	Def. value	Default unit	Unit ring
<Hour>, <Minute>, <Second>	Hours (0 to 23) Minutes (0 to 59) Seconds (0 to 59)	– – –	h min s	

Command description	FW vers.
This command sets the internal system time of the CMU.	≥ V 1.20

SYSTem:TIMe:DATe *<Year>,<Month>,<Day>* or
SYSTem:DATE *<Year>,<Month>,<Day>* Date

Parameters	Parameter description	Def. value	Default unit	Unit ring
<Year>,	Four-digit year (1980 to 2099)	–	–	
<Month>,	Month (1 to 12)	–		
<Day>	Day (1 to 31)	–		
Command description				FW vers.
This command sets the internal system date of the CMU.				≥ V 1.20

Subsystem MISC

The *MISC* subsystem sets the acoustic signal and selecting the external keyboard assignment. It corresponds to the *Misc.* tab in the *Setup* menu opened via the *SETUP* key on the front panel.

SYSTem:MISC:KBEep *<Enable>* Key Beep

<Enable>	Parameter description	Def. value	Default unit	Unit ring
ON |	Key beep on	OFF	–	
OFF	Key beep off			
Command description				FW vers.
This command switches the acoustic signal of the CMU on or off.				≥ V 1.20

SYSTem:MISC:KEYBoard *<Country>* Keyboard

<Country>	Parameter description	Def. value	Default unit	Unit ring
US |	American keyboard	US	–	
GR	German keyboard			
Command description				FW vers.
This command selects the driver for the external keyboard.				≥ V 1.20

Subsystem MQUeue

The *MQUeue* subsystem contains the commands for symbolic measurement ready evaluation. These commands are used to query the contents of the measurement queue. To activate the measurement queue, event reporting must not be switched off; see section *Event Reporting* in chapter 5.

SYSTem:MQUeue[:COMPlete][:LIST]? Complete Measurement Queue

Response	Parameter description	Def. value	Default unit	Unit ring
<FGroup_Mode>, **<MeasObject>, ...**	Function group and test mode Ready measurement	"NONE", "NONE"	–	

Command description	FW vers.
This command is always a query. It returns and deletes the contents of the complete measurement queue. The individual results are returned in chronological order (first in first out). Examples of possible responses are: "RF_NSig","POWer","RF_NSig","SPECtrum" Power and spectrum mesurement ready in function group *RF*, test mode *Non Signalling* "NONE", "NONE" No ready measurements reported	≥ V2.10

SYSTem:MQUeue[:COMPlete]:ITEM? Next Entry in Measurement Queue

Response	Parameter description	Def. value	Default unit	Unit ring
<FGroup_Mode>, **<MeasObject>**	Function group and test mode Ready measurement	"NONE", "NONE"	–	

Command description	FW vers.
This command is always a query. It returns and deletes the oldest ready measurement in the measurement queue.	≥ V2.10

Reset

The *Preset* subsystem contains the commands for resetting the default values. It corresponds to the *Reset* menu opened via the *RESET* key on the front panel.

SYSTem:PRESet[:ALL] Reset

Command description	FW vers.
This command sets all parameters of the instrument to their default values.	≥ V 1.20

Synchronization

The *Synchronize* subsystem contains the commands for configuring the reference frequency. It corresponds to the *Reference Frequency* softkey in the *Sync.* tab of the *Connection Control* menu. Note that this tab is available in every function group

CONFigure:SYNChronize:FREQuency:REFerence *<Frequency>*				Reference Frequency
<Frequency>	Parameter description	Def. value	Default unit	Unit ring
10 kHz to 52 MHz	Reference frequency	10 MHz	Hz	
Command description				FW vers.
The command defines the frequency of the synchronization signal.				≥ V 1.12

CONFigure:SYNChronize:FREQuency:REFerence:MODE *<Mode>*				Ref. Frequency Source
<Mode>	Parameter description	Def. value	Default unit	Unit ring
INTernal | **EXTernal**	internal reference frequency used external reference frequency used	INT	–	
Command description				FW vers.
The command defines the source of the synchronization signal.				≥ V 1.12

RF Measurements

Group Configuration

The remote-control commands presented in this section configure the measurements in the function group *RF Non Signalling* globally, i.e. for all subsequent measurements. They correspond to the settings in the popup menu of the *Group Config.* softkey located to the left of the header of each main menu (see chapter 3).

Subsystem LEVel (Input Level)

The subsystem *LEVel* contains the commands for determination and/or modification of the input level for the currently used input. It corresponds to the tab *Input Level* in the popup menu *Group Configuration* and the *Input Level – Reference* hotkey in the *Spectrum* or *Power* menu.

[SENSe:]LEVel:MAXimum *<Level>*				Max. Level
<Level>	Parameter description	Def. value	Default unit	Unit ring
0 dBm to +53 dBm **–14 dBm to 39 dBm** **–37 dBm to 0 dBm**	Max. input level for RF 1 Max. input level for RF 2 Max. input level for RF 4 IN	0.0 0.0 0.0	dBm	
Command description				FW vers.
This command defines the expected maximum input level for *Power vs Time* measurements and sets the input measurement path accordingly. The value range depends on the used RF input and the external attenuation.				≥ V 1.15

[SENSe:]LEVel:ATTenuation *<Mode>*				Attenuation
<Mode>	Parameter description	Def. value	Default unit	Unit ring
NORMal | **LNOise |** **LDIStortion**	Normal Low noise (level at mixer 10 dB higher than in normal setting) Low distortion factor (level at mixer 10 dB lower than in normal setting)	NORMal	–	
Command description				FW vers.
This command defines the attenuation or gain of the input measurement path.				≥ V 1.15

[SENSe:]LEVel:MODE *<Mode>*				Input level – Mode
<Mode>	Description of parameters	Def. value	Def. unit	Unit ring
MANual | **AUTomatic**	Manual setting Automatic setting corresponding to average power of signal applied	AUT	-	
Description of command				FW vers.
This command defines the mode for setting the maximum input level.				

[SENSe:]LEVel:REFerence *<Level>*		Reference Level for Spectrum		
<Level>	Parameter description	Def. value	Default unit	Unit ring
–100 dBm to +53 dBm **–100 dBm to +39 dBm** **–100 dBm to 0 dBm**	Reference level for RF 1 Reference level for RF 2 Reference level for RF 4 IN	+30 +30 0.0	dBm	
Command description				FW vers.
This command defines the reference level for *Spectrum* measurements.				≥ V 1.20

Subsystem TRIGger (Trigger Mode)

The subsystem *TRIGger* determines the trigger mode. It corresponds to the tab *Trigger* in the popup menu *Group Configuration.*

TRIGger[:SEQuence]:SOURce *<Source>*				Source
<Source>	Parameter description	Def. value	Default unit	Unit ring
IMMediate |	Continuous measurement (without reference to input signal)	IMM	–	
RFPower |	The RF signal controls triggering depending on the trigger level `(TRIG:SEQ:THR)`			
IFPower |	The IF signal controls triggering depending on the trigger level `(TRIG:SEQ:THR)`			
EXTern	External triggering (via connector AUX3)			
Command description				FW vers.
This command determines the trigger source.				≥ V 1.15

TRIGger[:SEQuence]:THReshold *<Threshold>*				Level
<Threshold>	Parameter description	Def. value	Default unit	Unit ring
LOW | **MEDium** | **HIGH**	Low trigger threshold (reference level - 26 dB) Medium trigger threshold (reference level - 16 dB) High trigger threshold (Reference level - 6 dB))	MED	–	
Command description				FW vers.
This command sets the trigger level, i.e. the signal level at which the measurement is triggered (see `TRIG:SEQ:SOUR`). The command is enabled for trigger source `RFPower` and `IFPower` only.				≥ V 1.15

TRIGger[:SEQuence]:SLOPe *<Slope>*				Slope
<Slope>	Parameter description	Def. value	Default unit	Unit ring
POSitive | **NEGative**	Rising slope Falling slope	POS	–	
Command description				FW vers.
This command determines the trigger slope. The command is disabled for trigger source `IMMediate`.				≥ V 1.15

TRIGger[:SEQuence]:DEFault *<Enable>*				Default Settings
<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | **OFF**	The parameters are set to their default values The parameters differ from the default values (partially or totally)	ON	–	
Description of command				FW vers.
If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting *OFF* has no effect). If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.				

Connection Control

The remote-control commands presented in this section define the analyzer and generator settings, the inputs and outputs used as well as the reference frequency. They correspond to the settings in the popup menu of the *Connect. Control* softkey located to the right of the header of each main menu (see chapter 3).

Subsystem RFANalyzer (Analyzer Settings)

The subsystem *RFANalyzer* determines the parameters for analyzer control. It corresponds to the *Analyzer tab* in the popup menu *Connect. Control*.

[SENSe:]RFANalyzer:FREQuency *<Frequency>*				Frequency
<Frequency>	Parameter description	Def. value	Default unit	Unit ring
50 kHz to 2.7 GHz	Frequency (0.1 Hz resolution)	1000 MHz	Hz	
Command description				FW vers.
This command defines the input frequency of the analyzer. The usable frequency range exceeds the specified range, see data sheet.				≥ V 1.15

[SENSe:]RFANalyzer:BANDwidth[:RESolution] *<Bandwidth>* [SENSe:]RFANalyzer:BWIDth[:RESolution] *<Bandwidth>*				Bandwidth
<Bandwidth>	Parameter description	Def. value	Default unit	Unit ring
10 Hz to 1 MHz | WIDE	Bandwidths of the analyzer (the values are rounded in the steps 1 | 2 | 3 | 5)	WIDE	–	
Command description				FW vers.
This command defines the bandwidth of the analyzer. If WIDE is set no restriction is placed on the input frequency.				≥ V 1.15

Measurement Object RFANalyzer

The subsystem *RFANalyzer* contains the commands for measuring the signal power. The subsystem corresponds to the *Analyzer* softkey in the *Analyzer/Generator* menu and to the popup menu *Power versus Time Configuration.*

Subsystem RFANalyzer (Measurement Control)

The subsystem *RFANalyzer* controls the RF analyzer. The subsystem corresponds to the *Analyzer Power* softkey in the *Analyzer/Generator* menu.

INITiate:RFANalyzer	Start new measurement	⇒ *RUN*
ABORt:RFANalyzer	Abort running measurement and switch off	⇒ *OFF*
STOP:RFANalyzer	Stop measurement after current evaluation period	⇒ *STOP*
CONTinue:RFANalyzer	Next measurement step (only *stepping mode*)	⇒ *RUN*

Command description	FW vers.
These commands have no query form. They start or stop the measurement, setting it to the status indicated in the top right column.	≥ V 1.15

CONFigure:RFANalyzer:EREPorting <*Mode*> Event Reporting

<Mode>	Parameter description	Def. value	Def. unit	Unit ring
SRQ |	Service request	OFF	–	
SOPC |	Single operation complete			
SRSQ |	SRQ and SRSQ			
OFF	No reporting			

Command description	FW vers.
This command defines the events generated when the measurement is terminated or stopped *(event reporting,* see chapter 5).	≥ V 1.15

FETCh:RFANalyzer:STATus? Measurement status

Returned value	Parameter description	Def. value	Def. unit	Unit ring
OFF |	Measurement in the *OFF* state (`*RST` or `ABORt`)	OFF	–	
RUN |	Running (after `INITiate, CONTinue` or `READ`)			
STOP |	Stopped (`STOP`)			
ERR |	*OFF* (could not be started)			
STEP |	Stepping mode *(<stepmode>=STEP)*			
RDY,	Stopped according to repetition mode and stop condition			
1 to 10000 |	Counter for current evaluation period			
NONE,	Counter not used	NONE	–	

Command description	FW vers.
This command is always a query. It returns the status of the measurement (see chapters 3 and 5).	≥ V 1.15

Subsystem RFANalyzer:CONTrol (Control)

The subsystem *RFANalyzer* defines the repetition mode of the RF analyzer.

CONFigure:RFANalyzer:CONTrol:REPetition *<Repetition> ,<StopCondition>,<Stepmode>*

Test cycles

<Repetition>	Parameter description	Def. value	Def. unit	Unit ring
CONTinuous | **SINGleshot |** **1 to 10000**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCondition>	Parameter description	Def. value	Def. unit	Unit ring
NONE	Continue measurement even in case of error	NONE	–	
<Stepmode>	Description of parameters	Def. value	Def. unit	Unit ring
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	

Command description	FW vers.
This command determines the number of statistics cycles and the stepping mode for the measurement. A stop condition is not available. **Note:** *In the case of READ commands (`READ:` to) the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*	≥ V 1.15

CONFigure:RFANalyzer:POWer:RTIMe <Time> Duration of broadband power measurement

<Time>	Parameter description	Def. value	Def. unit	Unit ring
0 to 1	Duration of measurement. Accuracy: ± 5E-7 s	20E-3	s	

Command description	FW vers.
This command permits to define the time period during which the peak power is determined. With the time 0, the power is immediately measured on the measurement start, i.e. the instantaneous value is measured.	≥ V 1.15

Subsystem RFANalyzer:POWer (Measured Values)

The subsystem *RFANalyzer:POWer* contains the commands for reading the analyzer power. The subsystem corresponds to the *Analyzer Power* panel in the *Analyzer/Generator* menu.

READ[:SCALar]:RFANalyzer:POWer? Start single shot measurement and return results
FETCh[:SCALar]:RFANalyzer:POWer? Read out measurement results (unsynchronized)
SAMPle[:SCALar]:RFANalyzer:POWer? Read out measurement results (synchronized)

Scalar measurement results

Returned value	Description	Def. value	Default unit	Unit ring
-120.0 dBm to 47.0 dBm	RF power analyzed by the CMU	NAN	dBm	

Command description	FW vers.
These commands are pure queries. They start a measurement and return the scalar measurement result.	≥ V 1.15

Generator Object RFGenerator

The subsystem *RFGenerator* determines the parameters for control of the RF generator. It corresponds to the *RF Generator* panel in the *Generator* tab in the popup menu *Connect. Control* and in the measurement menu *Analyzer/Generator*.

Subsystem RFGenerator (Generator Control)

The subsystem *RFGenerator* controls the RF generator.

INITiate:RFGenerator **ABORt:RFGenerator**	Start RF generator, reserve resources Switch off RF generator, release resources	⇒ *RUN* ⇒ *OFF*
Command description		FW vers.
These commands have no query form. They start or stop the RF generator, setting it to the status indicated in the top right column.		≥ V 1.15

FETCh:RFGenerator:STATus?				Generator status
Returned value	Parameter description	Def. value	Def. unit	Unit ring
OFF | **RUN |** **ERR**	Generator switched off (`ABORt` or `*RST`) Running (`INITiate`) Switched off (could not be started)	OFF	–	
Command description				FW vers.
This command is always a query. It returns the current generator status.				≥ V 1.15

Subsystem RFGenerator:LEVel (Level)

The subsystem *RFGenerator:LEVel* determines the level of the RF generator. It corresponds to the input field *RF Level* of the *Generator* panel (in *Connection Control*, *Generator* tab and in the *Analyzer/Generator* menu).

SOURce:RFGenerator:LEVel *<Level>*				RF Level
<Level>	Parameter description	Def. value	Def. unit	Unit ring
–137.0 to –27.0 dBm **–137.0 to –10.0 dBm** **–90.0 to +13.0 dBm**	RF1 level in the used timeslot RF2 level in the used timeslot RF 3 OUT level in the used timeslot	–27.0 –27.0 –27.0	dBm dBm dBm	
Command description				FW vers.
This command defines the RF generator level. The permissible value range depends on the used RF output of the CMU and the external attenuation. Moreover, in the SSB mode (see command `SOURce:RFGenerator:MODulation SSB`), the level ranges for all three connectors are shifted by –2 dB, and the the default value for RF1 OUT is –29.0 dBm.				≥ V 1.15

Subsystem RFGenerator:FREQuency (Frequency)

The subsystem *RFGenerator:FREQuency* determines the frequency of the internal RF generator. It corresponds to the *Frequency* softkey of the *Generator* panel (in *Connection Control*, *Generator* tab and in the *Analyzer/Generator* menu).

SOURce:RFGenerator:FREQuency <*Frequency*>				Frequency
<Frequency>	Parameter description	Def. value	Def. unit	Unit ring
100 kHz to 2.7 GHz	Output frequency (resolution 0.1 Hz)	1200 MHz	Hz	
Command description				FW vers.
This command defines the output frequency of the RF generator. The usable frequency range exceeds the specified range, see data sheet.				≥ V 1.15

Subsystem RFGenerator:MODulation (Frequency Modulation)

The subsystem *RFGenerator:MODulation* determines the frequency modulation of the internal RF generator. It corresponds to the *Modulation* and *SSB Frequency* softkeys in the *Generator* panel (in *Connection Control*, *Generator* tab and in the *Analyzer/Generator* menu).

SOURce:RFGenerator:MODulation <*State*>				Modulation
<State>	Parameter description	Def. value	Def. unit	Unit ring
OFF | **SSB |** **AM**	No modulation, continuous wave RF output signal shifted by a constant offset frequency RF output signal amplitude-modulated	OFF	–	
Command description				FW vers.
This command determines the modulation of the RF output signal. In the *SSB* mode, the frequency of the RF output signal is shifted by the frequency defined via `CONF:RFG:MOD:SSB:FREQ`. In the *AM* mode, the signal is modulated with the frequency defined via `CONF:RFG:MOD:SSB:FREQ` and with the modulation index defined via `CONF:RFG:MOD:AM:IND`: see below.				V1.15, V2.15 (AM)

SOURce:RFGenerator:MODulation:SSB:FREQuency <*Deviation*>				AF Frequency
<Deviation>	Parameter description	Def. value	Def. unit	Unit ring
–300 kHz to +300 kHz | **0 kHz to +300 kHz**	SSB frequency offset (resolution 1 kHz) AM modulation frequency	1000 1000	Hz Hz	
Command description				FW vers.
This command generates an AF frequency which defines either a frequency offset (if `SOUR:RFG:MOD` is set to `SSB`) or an AM modulation frequency (if `SOUR:RFG:MOD` is set to `AM`). A frequency offset can be either positive or negative; modulation frequencies must be positive.				V1.15, V2.15 (AM)

SOURce:RFGenerator:MODulation:AM:INDex <*Mod_Index*>				Modulation Index
<Mod_Index>	Parameter description	Def. value	Def. unit	Unit ring
0 % to 100 %	Modulation index	100	%	
Command description				FW vers.
This command defines the modulation index for AM modulation, i.e. the amplitude ration between the modulating AM signal to the RF carrier signal in percent.				V1.15, V2.15 (AM)

Subsystem RFGenerator:FHOPping (Frequency Hopping)

The subsystem *RFGenerator:FHOPping* determines the frequency hopping of the internal RF generator. It corresponds to the *Frequency Hopping* settings in the *Generator* Config. Popup in the tab *Hopping*.

SOURce:RFGenerator:FHOPping:STATe <State>				Frequency Hopping
<State>	Parameter description	Def. value	Def. unit	Unit ring
OFF | **ON**	No frequency hopping Frequency hopping active (between the frequencies set via `SOUR:RFG:FREQ` and `SOUR:RFG:FHOP:FREQ`)	OFF	–	
Command description				FW vers.
This command switches the hopping output frequency of the RF generator on or off.				≥ V 1.15

SOURce:RFGenerator:FHOPping:FREQuency <*Frequency*>				Hopping Frequency
<Frequency>	Parameter description	Def. value	Def. unit	Unit ring
absolute: **100.0 kHz to 2.7 GHz**	Hopping frequency (in multiples of 0.1 Hz)	0 MHz (Hopping off)	Hz	
relative: **depending on normal frequency**	within the rated generator frequency range			
Command description				FW vers.
This command defines the hopping output frequency of the RF generator. This alternative frequency and the frequency set via `SOUR:RFG:FREQ` are used for hopping. The command `SOUR:RFG:FHOP:FREQ:MODE` decides whether the value is meant to be relative to `SOUR:RFG:FREQ` or absolute.				≥ V 1.15

SOURce:RFGenerator:FHOPping:FREQuency:MODE <Mode>				Hopping Mode
<Mode>	Parameter description	Def. value	Def. unit	Unit ring
	Hopping frequency	RELative	–	
ABSolute |	Absolute with respect to the RF generator frequency			
RELative	Relative to the RF generator frequency			
Command description				FW vers.
This command decides whether the frequency set using `SOUR:RFG:FHOP:FREQ` is meant to be relative to `SOUR:RFG:FREQ` or absolute.				≥ V 1.15

Subsystem RFGenerator:PULSe (Ramping)

The subsystem *RFGenerator:PULSe* determines the ramping mode of the internal RF generator. It corresponds to the *Ramping* setting in the *Generator Config.* menu in the tab *Hopping.*

SOURce:RFGenerator:PULSe:STATe <State>				Ramping
<State>	Parameter description	Def. value	Def. unit	Unit ring
OFF | **ON**	CW signal Pulsed signal with 577 µs burst length	OFF	–	
Command description				FW vers.
This command determines whether the RF generator generates a CW signal or a GSM-like burst signal.				≥ V 1.15

Subsystem RFGenerator:BANDwidth (Bandwidth)

The subsystem *RFGenerator:BANDwidth* contains the command for determination of the bandwidth of the modulation filter. It corresponds to the *Modulation Filter* setting in the popup menu *Generator Config.* in the tab *Modulation.*

SOURce:RFGenerator:BANDwidth *<Bandwidth>* **SOURce:RFGenerator:BWIDth *<Bandwidth>***				Bandwidth
<Bandwidth>	Parameter description	Def. value	Default unit	Unit ring
OFF | **F30Khz |** **F300khz**	off (broadband) 30 kHz bandwidth 300 kHz bandwidth	F300	–	
Command description				FW vers.
This command defines the value of the modulation filter.				≥ V 1.15

Subsystem INPut, OUTPut, CORRection:LOSS (⊙/Ext. Att.)

The subsystem for input and output contains the commands for configuration of the input and output connectors. The subsystem corresponds to the tab ⊙/*Ext. Att.* in the popup menu *Connect. Control.*

INPut[:STATe] ***<State>*** RF Input

<State>	Parameter description	Def. value	Default unit	Unit ring
RF1	Connector RF1 used as input	RF2	–	
RF2	Connector RF2 used as input			
RF4	Connector RF4 IN used as input			

Command description	FW vers.
This command determines the connector to be used for incoming RF signals. The bidirectional connectors RF 1 and RF 2 can be used both as input and output connectors in the very same measurement (see `OUTPut[:STATe]`). Only one input and one output may be active at a time, which is why the currently active one is automatically deactivated on switchover.	≥ V 1.15

OUTPut[:STATe] ***<State>*** RF Output

<State>	Parameter description	Def. value	Default unit	Unit ring
RF1	Connector RF1 used as output	RF2	–	
RF2	Connector RF2 used as output			
RF3	Connector RF3 OUT used as output			

Command description	FW vers.
This command determines the connector to be used for outgoing RF signals. The bidirectional connectors RF 1 and RF 2 can be used both as input and output connectors in the very same measurement. Only one input and one output may be active at a time, which is why the currently active one is automatically deactivated.	≥ V 1.15

[SENSe:]CORRection:LOSS:INPut<nr>[:MAGNitude] ***<Absorption>***
SOURce:CORRection:LOSS:INPut<nr>[:MAGNitude] ***<Absorption>*** Ext. Att. Input

<Absorption>	Parameter description	Def. value	Default unit	Unit ring
–50 dB to +50 dB	Value for external attenuation at Input <nr>, where <nr> = 1,2	0.0	dB	
–90 dB to +90 dB	Value for external attenuation at Input <nr>, where <nr> = 4	0.0	dB	

Command description	FW vers.
This commands assigns an external attenuation value to the inputs of the instrument.	≥ V 1.15

[SENSe:]CORRection:LOSS:OUTPut<nr>[:MAGNitude] *<Absorption>*
SOURce:CORRection:LOSS:OUTPut<nr>[:MAGNitude] *<Absorption>>* Ext. Att. Output

<Absorption>	Parameter description	Def. value	Default unit	Unit ring
–50 dB to +50 dB	Value for external attenuation at output <nr>, where <nr> = 1,2	0.0	dB	
–90 dB to +90 dB	Value for external attenuation at output <nr>, where <nr> = 3	0.0	dB	

Command description	FW vers.
This command assigns an external attenuation value to the outputs of the instrument.	≥ V 1.15

Subsystem DM:CLOCk (Synchronization)

The subsystem *DM:CLOCk* sets a network-specific system clock. The subsystem corresponds to the tab *Sync.* in the popup menu *Connect. Control.*

SOURce:DM:CLOCk:STATe *<Mode>* REF OUT 2

<Mode>	Parameter description	Def. value	Def. unit	Unit ring
ON | OFF	Switch system clock on/off	OFF	–	

Command description	FW vers.
This command switches the system clock at the output *REF OUT 2* on or off.	≥ V 1.15

SOURce:DM:CLOCk:FREQuency <Frequency> Clock Frequency

<Frequency>	Parameter description	Def. value	Def. unit	Unit ring
1.219 MHz to 39.000 MHz	Frequency of network-specific system clock	13	MHz	

Command description	FW vers.
This command defines the frequency at the output *REF OUT2*. In FW V2.15ff, the frequency entered is rounded to the following discrete values:	≥ V 1.15

40.000 MHz, 20.000 MHz, 13.333 MHz, 10.000 MHz, 8.000 MHz, 6.667 MHz, 5.714 MHz,
5.000 MHz, 4.444 MHz, 4.000 MHz, 3.636 MHz, 3.333 MHz, 3.077 MHz, 2.857 MHz,
2.667 MHz, 2.500 MHz, 2.353 MHz, 2.222 MHz, 2.105 MHz, 2.000 MHz, 1.905 MHz,
1.818 MHz, 1.739 MHz, 1.667 MHz, 1.600 MHz, 1.538 MHz, 1.481 MHz, 1.429 MHz,
1.379 MHz, 1.333 MHz, 1.290 MHz, 1.250 MHz

The formula of the sequence reads as follows:

$f_n = f_1 \frac{1}{n}$ with $n = 1, 2, 3, \ldots 32$ and $f_1 = 39$ MHz for RF

If the entered value f lies between two permissible discrete values f_n and f_{n+1}, it is rounded to

$$f \rightarrow f_n \text{ if } f \geq f_1 \frac{1}{n+0.5} \text{ and}$$

$$f \rightarrow f_{n+1} \text{ if } f < f_1 \frac{1}{n+0.5}.$$

Measurement Object POWer (Power vs. Time)

The subsystem *POWer* contains the commands for measurement of the signal power. The subsystem corresponds to the measurement menu *Power versus Time* and the associated popup menu *Power versus Time Configuration.*

Subsystem POWer (Measurement Control)

The subsystem *POWer* contains the commands controlling the power measurement. The subsystem corresponds to the *Power vs Time* main softkey.

INITiate:POWer	Start new measurement	⇒ *RUN*
ABORt:POWer	Abort running measurement and switch off	⇒ *OFF*
STOP:POWer	Stop measurement after current evaluation period	⇒ *STOP*
CONTinue:POWer	Next measurement step (only *stepping mode*)	⇒ *RUN*

Command description	FW vers.
These commands have no query form. They start or stop the measurement, setting it to the status indicated in the top right column.	≥ V 1.15

CONFigure:POWer:EREPorting *<Mode>* Event reporting of the measurement

<Mode>	Parameter description	Def. value	Def. unit	Unit ring
SRQ |	Service request	OFF	–	
SOPC |	Single operation complete			
SRSQ |	SRQ and SOPC			
OFF	No reporting			

Command description	FW vers.
This command defines the events generated when the measurement is terminated or stopped *(event reporting,* see chapter 5).	≥ V 1.15

FETCh:POWer:STATus? Measurement status

Returned value	Parameter description	Def. value	Def. unit	Unit ring
OFF |	Measurement in the *OFF* state (`*RST` or `ABORt`)	OFF	–	
RUN |	Running (after `INITiate, CONTinue` or `READ`)			
STOP |	Stopped (`STOP`)			
ERR |	*OFF* (could not be started)			
STEP |	Stepping mode *(<stepmode>=STEP)*			
RDY,	Stopped according to repetition mode and stop condition			
0 to 10000 |	Counter for evaluation periods (meas. cycles)	NONE	–	
NONE	Counter not used			

Command description	FW vers.
This command is always a query. It returns the status of the measurement (see chapters 3 and 5).	≥ V 1.15

Subsystem POWer:CONTrol (Control)

The subsystem *POWer:CONTrol* defines the scope of the *Power vs Time* measurement. The subsystem corresponds to the *Control* tab of the *Power vs Time Configuration* menu.

CONFigure:POWer:CONTrol <*Mode*> Scope of measurement

<Mode>	Desciption of parameters	Def. value	Def. unit	Unit ring
SCALar | **ARRay**	Scalar values only (incl. ramp matching) Scalar measured values and arrays	ARRay	–	

Description of command	FW-Vers.
This command specifies the type of measured values.	≥1.15

CONFigure:POWer:CONTrol:REPetition <*Repetition*> ,<*StopCondition*>,<*Stepmode*> Measurement cycles

<Repetition>	Parameter description	Def. value	Def. unit	Unit ring
CONTinuous | **SINGleshot |** **1 to 10000**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCondition>	Parameter description	Def. value	Def. unit	Unit ring
NONE	Continue measurement even in case of error	NONE	–	
<Stepmode>	Description of parameters	Def. value	Def. unit	Unit ring
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	

Command description	FW vers.
This command defines the repetition mode and the stepping mode for the measurement. A stop condition is not available. **Note:** *In the case of READ commands (`READ:` to) the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*	≥ V 1.15

DISPlay:POWer:CONTrol:GRID <*Enable*> Grid

<Enable>	Parameter description	Def. value	Default unit	Unit ring
ON | **OFF**	Switch on grid lines Switch off grid lines	ON	–	

Command description	FW vers.
This command switches the grid lines on or off in the test diagram.	≥ V 1.15

Subsystem POWer:FREQuency (Frequency/RBW)

The subsystem *POWer:FREQuency* sets the frequency and resolution bandwidth of the *Power versus Time* measurement. The subsystem corresponds to the *Analyzer Settings* softkey in the graphical measurement menu *Power versus Time.*

[SENSe:]POWer:FREQuency:CENTer *<Frequency>*				Frequency
<Frequency>	Parameter description	Def. value	Default unit	Unit ring
10 kHz to 2.7 GHz	Frequency (0.1 Hz resolution)	1000 MHz	Hz	
Command description				FW vers.
This command defines the input frequency of the analyzer.				≥ V 1.15

[SENSe:]POWer:FREQuency:BANDwidth[:RESolution] *<Bandwidth>* **[SENSe:]POWer:FREQuency:BWIDth[:RESolution] *<Bandwidth>***				RBW
<Bandwidth>	Parameter description	Def. value	Default unit	Unit ring
10 Hz to 1 MHz	Bandwidths of power measurement (the values are rounded in the steps 1 | 2 | 3 | 5)	300 kHz	–	
Command description				FW vers.
This command defines the bandwidth of the power measurement.				≥ V 1.15

Subsystem POWer:LEVel (Level)

The subsystem *POWer:LEVel* sets the level range displayed. The subsystem corresponds to the *Level Scale* hotkey in the graphical measurement menu *Power versus Time.*

[SENSe:]POWer:LEVel:RANGe *<Range>*				Range
<Range>	Parameter description	Def. value	Default unit	Unit ring
10 dB to 100 dB	Level range of the power measurement (the values are rounded in the steps 1 | 2 | 3 | 5 | 8)	100 dB	–	
Command description				FW vers.
This command defines the level range of the *Power vs Time* measurement.				≥ V 1.15

Subsystem POWer:TIME

The subsystem *POWer:TIME* configures the time axis. The subsystem corresponds to the *Time Scale* hotkey in the graphical measurement menu *Power versus Time.*

[SENSe:]POWer:TIME:DELay *<Delay>* Delay

<Delay>	Parameter description	Def. value	Default unit	Unit ring
See below	Delay time between trigger time and start of the measurement	–10.0 µs	s	

Command description	FW vers.
This command defines the time when the measurement is started relative to the trigger time. The permissible range of delays depends on the span and bandwidth, e.g.: - 152.9 µs to 142.9 µs (bandwidth 1 MHz, span 10 µs) - 15.7919207 s to 5.7919207 s (bandwidth 10 Hz, span 10 s)	≥ V 1.15

[SENSe:]POWer:TIME:SPAN *<Span>* Span

<Span>	Parameter description	Def. value	Default unit	Unit ring
10 µs to 10 s	Span of the power measurement	100 µs	s	

Command description	FW vers.
This command defines the span (i.e. the total evaluation time) of the *Power vs Time* measurement. The permissible spans depend on the selected bandwidth.	≥ V 1.15

CONFigure:POWer:CONTrol:TIMeout *<Timeout>* Timeout for triggered measurements

<Timeout>	Parameter description	Def. value	Default unit	Unit ring
1 s to 60 s	Timeout period after which the measurement is aborted	10 s	s	

Command description	FW vers.
This command defines a timeout period after which the measurement is aborted (e.g. if no trigger event could be detected).	≥ V 1.15

Subsystem SUBarrays:POWer

The subsystem *SUBarrays:POWer* defines the measurement range and the type of output values.

CONFigure:SUBarrays:POWer Definition of Subarrays

<Mode>,<Start>,<Samples>{,<Start>,<Samples>}

<Mode>	Description of parameters	Def. value	Def. unit	Unit ring
ALL | **ARIThmetical |** **MINimum |** **MAXimum |** **IVAL,**	Return all measurement values Return arithm. mean value in every subrange Return minimum value in every subrange Return maximum value in every subrange Return single interpolated value at <Start>	ALL	–	
<Start>	Description of parameters	Def. value	Def. unit	Unit ring
–15 s to 15 s,	Start time in current range	Min	s	
<Samples>	Description of parameters	Def. value	Def. unit	Unit ring
1 to 500	Number of samples in current subrange	Max	–	

Description of command	FW vers.
This command configures the `READ:SUBarrays:POWer...`, `FETCh:SUBarrays:POWer...`, and `SAMPle:SUBarrays:POWer` commands. It restricts the measurement to up to 32 subranges where either all measurement results (the number of which is given by the second numerical parameter) or a single statistical value is returned. The subranges are defined by the start time and the number of test points to be measured.	3.0

For <Mode> = IVAL, the <Samples> parameter is ignored and the CMU returns a single measurement value corresponding to the abscissa value <Start>. If <Start> is located between two test points with valid results then the result is calculated from the results at these two adjacent test points by linear interpolation.

The subranges may overlap but must be within the total range of the `POWer` measurement defined via `[SENSe:]POWer:TIME:DELay` and `[SENSe:]POWer:TIME:SPAN`. Test points outside this range are not measured (result *NAN)* and do not enter into the `ARIThmetical`, `MINimum` and `MAXimum` values.

By default, only one range corresponding to the total measurement range is used and all measurement values are returned.

Subsystem POWer:BURSt (Measured Values)

The subsystem *POWer:BURSt* contains the commands for measurement and output of the measured power versus the time. The subsystem corresponds to the graphical measurement menu *Power versus Time.*

	Power versus Time Results
READ:ARRay:POWer[:CURRent]?	Start single shot measurement and return results
FETCh:ARRay:POWer[:CURRent]?	Read out measurement results (unsynchronized)
SAMPle:ARRay:POWer[:CURRent]?	Read out measurement results (synchronized)

Returned value	Parameter description	Def. value	Default unit	Unit ring
–128.0 dBm to + 47.0 dBm,	1st value for power	NAN	dBm	
...,				
–128.0 dBm to + 47.0 dBm	500th value for power	NAN	dBm	

Command description	FW vers.
These commands are always queries. They return the power values versus the time at 1000 equidistant test points. The measurement range is defined via `[SENSe:]POWer:TIME:DELay` and `[SENSe:]POWer:TIME:SPAN`. **Note:** *The number of test points may be reduced at very narrow measurement ranges.*	≥ V 1.15

READ:SUBarrays:POWer[:CURRent]?	Subarray Results Start single shot measurement and return results	⇒ *RUN*
FETCh:SUBarrays:POWer[:CURRent]?	Read meas. results (unsynchronized)	⇒ *RUN*
SAMPle:SUBarrays:POWer[:CURRent]?	Read results (synchronized)	⇒ *RUN*

Ret. values by subrange	Description of parameters	Def. value	Def. unit	Unit ring
–128.0 dBm to + 48.0 dBm	Power[1], 1st value for power	NAN	dBm	
...	...	...	...	
–128.0 dBm to + 48.0 dBm	Power[x], xth value for power	NAN	dBm	

Description of command	FW vers.
These commands are always queries. They return the burst power versus time in the subranges defined by means of the `CONFigure:SUBarrays:POWer` command. In the default setting of the configuration command the `READ:SUBarrays...`, `FETCh:SUBarrays...`, and `SAMPle:SUBarrays...` command group is equivalent to the `READ:ARRay...`, `FETCh:ARRay...`, and `SAMPle:ARRay...` command group described above. The `CONFigure:SUBarrays:POWer` command defines a maximum of 32 subranges. If one of the statistical modes (`ARIThmetical`, `MINimum`, `MAXimum`) or `IVAL` is set, only one value is returned by subrange.	3.0

Measurement Object SPECtrum

The subsystem *SPECtrum* contains the commands for measurement of the frequency spectrum. The subsystem corresponds to the measurement menu *Spectrum* and the associated popup menu *Spectrum Configuration.*

Subsystem SPECtrum (Measurement Control)

The subsystem *SPECtrum* contains the commands controlling the spectrums. It corresponds to the *Spectrum.* softkey in the measurement menu *Spectrum.*

INITiate:SPECtrum	Start new measurement	⇒ *RUN*
ABORt:SPECtrum	Abort running measurement and switch off	⇒ *OFF*
STOP:SPECtrum	Stop measurement after current evaluation period	⇒ *STOP*
CONTinue:SPECtrum	Next measurement step (only *stepping mode*)	⇒ *RUN*
Command description		FW vers.
These commands have no query form. They start or stop the measurement, setting it to the status indicated in the top right column.		≥ V 1.15

CONFigure:SPECtrum:EREPorting <*Mode*>				Event Reporting
<Mode>	Parameter description	Def. value	Def. unit	Unit ring
SRQ | **SOPC |** **SRSQ |** **OFF**	Service request Single operation complete SRQ and SOPC No reporting	OFF	–	
Command description				FW vers.
This command defines the events generated when the measurement is terminated or stopped *(event reporting,* see chapter 5).				≥ V 1.15

FETCh:SPECtrum:STATus?				Measurement status
Returned value	Parameter description	Def. value	Def. unit	Unit ring
OFF | **RUN |** **STOP |** **ERR |** **STEP |** **RDY,**	Measurement in the *OFF* state (`*RST` or `ABORt`) Running (after `INITiate, CONTinue` or `READ`) Stopped (`STOP`) *OFF* (could not be started) Stepping mode *(<stepmode>=STEP)* Stopped according to repetition mode and stop condition	OFF	–	
0 to 10000 | **NONE**	Counter for measurement cycles Counter not used	NONE	–	
Command description				FW vers.
This command is always a query. It returns the status of the measurement (see chapters 3 and 5).				≥ V 1.15

Subsystem SPECtrum:CONTrol

The subsystem *SPECtrum:CONTrol* contains the commands defining the scope of the spectrum measurement. It corresponds to the tab *Control* in the popup menu *Spectrum Configuration.*

CONFigure:SPECtrum:CONTrol <*Mode*>				Scope of measurement
<Mode>	Desciption of parameters	Def. value	Def. unit	Unit ring
SCALar | **ARRay**	Scalar values only (incl. ramp matching) Scalar measured values and arrays	ARRay	–	
Description of command				FW-Vers.
This command specifies the type of measured values.				≥1.15

CONFigure:SPECtrum:CONTrol:REPetition <*Repetition*> ,<*StopCondition*>,<*Stepmode*>				Measurement cycles
<Repetition>	Parameter description	Def. value	Def. unit	Unit ring
CONTinuous | **SINGleshot |** **1 to 10000**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCondition>	Parameter description	Def. value	Def. unit	Unit ring
NONE	Continue measurement in case of error	NONE	–	
<Stepmode>	Description of parameters	Def. value	Def. unit	Unit ring
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	
Command description				FW vers.
This command defines the repetition mode and the stepping mode for the measurement. A stop condition is not available. ***Note:*** *In the case of READ commands (`READ:` to) the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*				≥ V 1.15

DISPlay:SPECtrum:CONTrol:GRID <*Enable*>				Grid
<Enable>	Parameter description	Def. value	Default unit	Unit ring
ON | **OFF**	Switch on grid lines Switch off grid lines	ON	–	
Command description				FW vers.
This command switches the grid lines on or off in the test diagram.				≥ V 1.15

Subsystem SPECtrum:FREQuency (Frequency/RBW)

The subsystem *SPECtrum:FREQuency* defines the display range of the frequency axis and the resolution bandwidth. The subsystem corresponds to the *Analyzer Settings* softkey in the graphical measurement menu *Spectrum.*

[SENSe:]SPECtrum:FREQuency:CENTer *<Frequency>* Center / Span / Start
[SENSe:]SPECtrum:FREQuency:SPAN *<Frequency>*
[SENSe:]SPECtrum:FREQuency:STARt *<Frequency>*
[SENSe:]SPECtrum:FREQuency:STOP *<Frequency>*

<Frequency>	Parameter description	Def. value	Default unit	Unit ring
10.0 MHz to 2.7 GHz	Center frequency	1105	MHz	
0.00001 MHz to 2.690 GHz	Frequency span	2190	MHz	
10 MHz to 2.7 GHz	Start frequency	10	MHz	
10.00001 MHz to 2.7 GHz	Stop frequency	2200	MHz	

Command description	FW vers.
This command sets the center frequency and span or the start and stop frequency of the spectrum analyzer. Start and stop frequency are used for calculation of the other two frequencies.	≥ V 1.15

[SENSe:]SPECtrum:FREQuency:BANDwidth[:RESolution] *<Bandwidth>*
[SENSe:]SPECtrum:FREQuency:BWIDth[:RESolution] *<Bandwidth>* RBW

<Bandwidth>	Parameter description	Def. value	Default unit	Unit ring
10 Hz to 1 MHz | AUTO	Bandwidths of measurement (the values are rounded in the steps 1 | 2 | 3 | 5)	AUTO	–	

Command description	FW vers.
This command defines the bandwidth of the spectrum measurement. The range of the bandwidth is shifted and increased along with the span of the measurement.	≥ V 1.15

Subsystem SPECtrum:LEVel (Level)

The subsystem *POWer:LEVel* sets the level range of the *Spectrum* measurement. The subsystem corresponds to the *Level Scale* hotkey in the graphical measurement menu *Spectrum.*

[SENSe:]SPECtrum:LEVel:RANGe *<Range>* Range

<Range>	Parameter description	Def. value	Default unit	Unit ring
10 dB to 100 dB	Level range for the spectrum measurement.	100 dB	–	

Command description	FW vers.
This command defines the level range for the spectrum measurement. The input values are rounded in steps of 1 | 2 | 3 | 5 | 8.	≥ V 1.15

Subsystem SUBarrays:SPECtrum

The subsystem *SUBarrays:SPECtrum* defines the measurement range and the type of output values.

CONFigure:SUBarrays:SPECtrum Definition of Subarrays
<Mode>,<Start>,<Samples>{,<Start>,<Samples>}

<Mode>	Description of parameters	Def. value	Def. unit	Unit ring
ALL |	Return all measurement values	ALL	–	
ARIThmetical |	Return arithm. mean value in every subrange			
MINimum |	Return minimum value in every subrange			
MAXimum |	Return maximum value in every subrange			
IVAL,	Return single interpolated value at <Start>			

<Start>	Description of parameters	Def. value	Def. unit	Unit ring
10 MHz to 2.69999999 GHz,	Start frequency in current range	Min	Hz	

<Samples>	Description of parameters	Def. value	Def. unit	Unit ring
1 to 560	Number of samples in current subrange	Max	–	

Description of command	FW vers.
This command configures the `READ:SUBarrays:SPECtrum...`, `FETCh:SUBarrays:SPECtrum...`, and `SAMPle:SUBarrays:SPECtrum` commands. It restricts the measurement to up to 32 subranges where either all measurement results (the number of which is given by the second numerical parameter) or a single statistical value is returned. The subranges are defined by the start frequency and the number of test points to be measured.	3.0

For <Mode> = IVAL, the <Samples> parameter is ignored and the CMU returns a single measurement value corresponding to the abscissa value <Start>. If <Start> is located between two test points with valid results then the result is calculated from the results at these two adjacent test points by linear interpolation.

The subranges may overlap but must be within the total range of the `SPECtrum` measurement defined by the commands `[SENSe:]SPECtrum:FREQuency:CENTer` and `[SENSe:]SPECtrum:FREQuency:SPAN` or by `[SENSe:]SPECtrum:FREQuency:STARt` and `[SENSe:]SPECtrum:FREQuency:STOP`. Test points outside this range are not measured (result *NAN)* and do not enter into the `ARIThmetical, MINimum` and `MAXimum` values.

By default, only one range corresponding to the total measurement range is used and all measurement values are returned.

Subsystem SPECtrum (Measured Values)

The subsystem *SPECtrum* contains the commands for measurement and output of the spectrum measurement. The subsystem corresponds to the various output elements in the graphical measurement menu *Spectrum*.

	Spectrum Results
READ:ARRay:SPECtrum[:CURRent]?	Start single shot measurement and return results
FETCh:ARRay:SPECtrum[:CURRent]?	Read out meas. results (unsynchronized)
SAMPle:ARRay:SPECtrum[:CURRent]?	Read out measurement results (synchronized)

Returned value	Parameter description	Def. value	Default unit	Unit ring
–128.0 dBm to + 48.0 dBm	1st power value	NAN	dBm	
...				
–128.0 dBm to + 48.0 dBm	560th power value	NAN	dBm	

Command description	FW vers.
These commands are always queries. They return the results of the spectrum measurement at 560 equidistant test points. The measurement range is defined by the commands `[SENSe:]SPECtrum:FREQuency:CENTer` and `[SENSe:]SPECtrum:FREQuency:SPAN` or by `[SENSe:]SPECtrum:FREQuency:STARt` and `[SENSe:]SPECtrum: FREQuency:STOP`. ***Note:*** *The number of test points may be reduced at very narrow measurement ranges.*	≥ V 1.15

	Subarray Results
READ:SUBarrays:SPECtrum[:CURRent]?	
Start single shot measurement and return results	⇒ *RUN*
FETCh:SUBarrays:SPECtrum[:CURRent]?	
Read meas. results (unsynchronized)	⇒ *RUN*
SAMPle:SUBarrays:SPECtrum[:CURRent]?	
Read results (synchronized)	⇒ *RUN*

Ret. values by subrange	Description of parameters	Def. value	Def. unit	Unit ring
–128.0 dBm to + 48.0 dBm	Power[1], 1st value for power	NAN	dBm	
...	...	...	...	
–128.0 dBm to + 48.0 dBm	Power[x], xth value for power	NAN	dBm	

Description of command	FW vers.
These commands are always queries. They return the burst power versus frequency in the subranges defined by means of the `CONFigure:SUBarrays:SPECtrum` command. In the default setting of the configuration command the `READ:SUBarrays...`, `FETCh:SUBarrays...`, and `SAMPle:SUBarrays...` command group is equivalent to the `READ:ARRay...`, `FETCh:ARRay...`, and `SAMPle:ARRay...` command group described above. The `CONFigure:SUBarrays:SPECtrum` command defines a maximum of 32 subranges. If one of the statistical modes (`ARIThmetical`, `MINimum`, `MAXimum`) or `IVAL` is set, only one value is returned by subrange.	3.0

Audio Generator and Analyzer (with Option CMU-B41)

Audio measurements form a separate function group (*Non Signalling* mode) with associated secondary address. The mode “Signalling” is not available for the function group *Audio*. However, it is possible to perform audio measurements while using the signalling modes from other function groups (e.g. establish a call to a mobile in function group *GSM900/1800/1900-MS Signalling* and switch over to perform additional audio measurements). Consequently, additional audio-related commands may be provided in other contexts (for example, see the `ROUTe:SPENcoder...` and `ROUTe:SPDecoder...` commands in the *GSM900/1800/1900-MS* function groups).

The *Audio* measurement is divided into the two subsystems for AF Generator (subsystem `AFGenerator`) and AF Analyzer (subsystem `AFANalyzer`) control. In remote control, two independent circuits are provided:

- In the primary audio circuit (subsystems `AFANalyzer[:PRIMary]...` and `AFGenerator[:PRIMary]`), the audio signals are applied to the connectors AF OUT (output, AF generator signal) and AF IN (input) on the CMU front panel. The primary audio circuit corresponds to the *Audio Analyzer/Generator* menu and the associated configuration menu.
- In the secondary audio circuit (subsystems `AFANalyzer:SECondary...` and `AFGenerator:SECondary`), the audio signals are applied to the connectors AUX 2 (output, AF generator signal) and AUX 1 (input) on the CMU front panel. The secondary audio circuit can not be controlled manually.

With the exception of the input and output connectors, the two audio circuits are identical. All remote control commands are analogous.

Subsystem AFLevel (AF Input Level)

The subsystem *AFLevel* determines the input level for the currently used input. It corresponds to the *Mode* and *Manual Level* section in the *Control* tab of the *Analyzer Configuration* menu and to the *Analyzer Level* softkey with the hotkeys *Mode* and *AF Max. Level* in the *Audio Multitone* measurement menu.

[SENSe:]AFLevel:MODE *<Mode>*				Input level – Mode
<Mode>	Description of parameters	Def. value	Def. unit	Unit ring
MANual | **AUTomatic**	Manual setting Automatic setting corresponding to average power of signal applied	AUT	–	
Description of command				FW vers.
This command defines the mode for setting the maximum input level.				V3.0

[SENSe:]AFLevel:MAXimum *<Level>*				AF Max. Level
<Level>	Description of parameters	Def. value	Def. unit	Unit ring
0 V to +30 V	Maximum audio input voltage	1	V	
Description of command				FW vers.
This command defines the maximum expected AF input level.				V3.0

[SENSe:]AFLevel:DEFault				Default Settings
<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	
Description of command				FW vers.
If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting OFF results in an error message). If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.				V3.0

Measurement Object AFANalyzer

The measurement object AFANalyzer contains the commands for measuring the audio signal. It corresponds to the *Analyzer* softkey in the main menu *Audio Analyzer/Generator* and the associated output fields.

Subsystem AFANalyzer (Measurement Control)

The subsystem *AFAnalyzer* contains the commands for general control of the audio analysis.

		Analyzer
INITiate:AFANalyzer[:PRIMary] **INITiate:AFANalyzer:SECondary**	Start new AF measurement	⇒ *RUN*
STOP:AFANalyzer[:PRIMary] **STOP:AFANalyzer:SECondary**	Stop AF measurement after current evaluation period	⇒ *STOP*
ABORt:AFANalyzer[:PRIMary] **ABORt:AFANalyzer:SECondary**	Abort and switch off AF analyzer	⇒ *OFF*
CONTinue:AFANalyzer[:PRIMary] **CONTinue:AFANalyzer:SECondary**	Next measurement step (only stepping mode)	⇒ *RUN*
Description of command		FW vers.
These commands have no query form. They start and stop the AF analyzer, setting it to the status given in the top right column.		≥ V2.10

CONFigure:AFANalyzer[:PRIMary]:EREPorting *<Mode>* **CONFigure:AFANalyzer:SECondary:EREPorting *<Mode>***				Event Reporting
<Mode>	Description of parameters	Def. value	Def. unit	Unit ring
SRQ | **SOPC |** **SRSQ |** **OFF**	Service request Single operation complete SRQ and SRSQ No reporting	OFF	–	
Description of command				FW vers.
This command defines the events generated when the measurement is terminated or stopped (event reporting see chapter 5)				≥ V2.10

FETCh:AFANalyzer[:PRIMary]:STATus? **FETCh:AFANalyzer:SECondary:STATus?**				Measurement Status
Return	Description of parameters	Def. value	Def. unit	Unit ring
OFF |	Measurement in the OFF state (`*RST` or `ABORt`)	OFF	–	
RUN |	Running (after `INITiate`, `CONTinue` or `READ`)			
STOP |	Stopped (`STOP`)			
ERR |	OFF (could not be started)			
STEP |	Stepping mode (`<stepmode> = STEP`)			
RDY ,	Stopped according to repetition mode and stop condition			
1 to 10000 |	Counter for current statistics cycle			
NONE	No counting mode set	NONE	–	
Description of command				FW vers.
This command is always a query. It returns the status of the measurement (see chapters 3 and 5) and the number of the current statistics cycle.				≥ V2.10

CONFigure:AFANalyzer[:PRIMary]:MTReduce <Mode>, <Frequency> **CONFigure:AFANalyzer:SECondary:MTReduce**				Reduce Measurement Time
<Mode>	Description of parameters	Def. value	Def. unit	Unit ring
LOWF |	Measurement time according to lowest frequency (10 kHz)	LOWF	–	
EXPF	Measurement time according to *<Frequency>*			
<Frequency>	Description of parameters	Def. value	Def. unit	Unit ring
10 Hz to 20 kHz	Expected frequency of the audio input signal	100	Hz	–
Description of command				FW vers.
This command is to reduce the measurement time the audio analyzer uses to calculate the measurement results *(<Mode>=EXPF);* see section *Subsystem AFANalyzer... (Measured Values)* on page 6.47. The measurement time must be adapted to the period of the input signal, which is the reverse of the frequency. Therefore, the audio measurement can be accelerated for high-frequency signals. In the *LOWF* mode, *<Frequency>* is not taken into account.				V3.0

Subsystem AFANalyzer...:CONTrol (Control)

The subsystem *AFANalyzer:...CONTrol* contains the commands for the configuration of the audio analysis. It corresponds to the *Analyzer Configuration* popup menu.

CONFigure:AFANalyzer[:PRIMary]:CONTrol:REPetition
CONFigure:AFANalyzer:SECondary:CONTrol:REPetition
<Repetition>, <StopCondition>, <Stepmode>
Test Cycles

<Repetition>	Description of parameters	Def. value	Def. unit	Unit ring
CONTinuous | **SINGleshot |** **1 to 10000**	Continuous measurement (until `STOP` or `ABORt`) Single shot measurement (until `Status = RDY`) Multiple measurement (counting, `until Status = STEP | RDY`)	SING	–	

<StopCondition>	Description of parameters	Def. value	Def. unit	Unit ring
NONE	Continue measurement even in case of error	NONE	–	

<Stepmode>	Description of parameters	Def. value	Def. unit	Unit ring
STEP | **NONE**	Interrupt measurement after each statistic cycle Continue measurement according to its rep. mode	NONE	–	

Description of command	FW vers.
This command determines the number of statistics cycles and the stepping mode for the measurement. A stop condition is not available. **Note:** *In the case of READ commands (`READ`: to) the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*	≥ V2.10

CONFigure:AFANalyzer[:PRIMary]:CONTrol:COUPling *<Coupling>*
CONFigure:AFANalyzer:SECondary:CONTrol:COUPling *<Coupling>*
AF Path Coupling

<Coupling>	Description of parameters	Def. value	Def. unit	Unit ring
AC | **DC**	AC coupling of AF path DC coupling of AF path	AC	–	

Description of command	FW vers.
This command determines the AF path coupling for measurements using the AF analyzer.	≥ V2.10

CONFigure:AFANalyzer[:PRIMary]:CONTrol:DISTortion[:FREQuency] *<Frequency>*
CONFigure:AFANalyzer:SECondary:CONTrol:DISTortion[:FREQuency] *<Frequency>*
Frequency

<Frequency>	Description of parameters	Def. value	Def. unit	Unit ring
20 Hz to 20000 Hz	Reference frequency for distortion measurement	1000	Hz	

Description of command	FW vers.
This command determines the reference frequency for the harmonic distortion measurement.	≥ V2.10

Subsystem AFANalyzer...:FILTer (Filter)

The subsystem *`AFANalyzer:...FILTer`* contains the commands for the configuration of the audio analysis filter. The input path of the AF analyzer is as shown below:

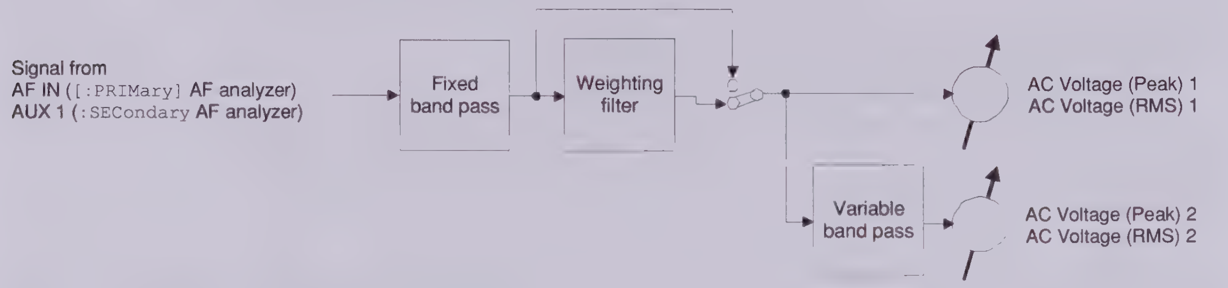
Signal from
AF IN ([:PRIMary] AF analyzer)
AUX 1 (:SECondary AF analyzer)
Fixed band pass
Weighting filter
Variable band pass
AC Voltage (Peak) 1
AC Voltage (RMS) 1
AC Voltage (Peak) 2
AC Voltage (RMS) 2

Fig. 6-1 AF analyzer input path configuration

Note: *This subsystem has no equivalent in manual control.*

CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:CFRequency *<Center>* **CONFigure:AFANalyzer:SECondary:FILTer:VBPass:CFRequency *<Center>***				Frequency
<Center>	Description of parameters	Def. value	Def. unit	Unit ring
20 Hz to 20000 Hz	Center frequency of band pass	1000	Hz	
Description of command				FW vers.
This command determines the center frequency of the variable band pass.				≥ V2.12

CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:BWIDth *<Bandwidth>* **CONFigure:AFANalyzer:SECondary:FILTer:VBPass:BWIDth *<Bandwidth>***				Bandwidth
<Bandwidth>	Description of parameters	Def. value	Def. unit	Unit ring
10 Hz to 1000 Hz	Bandwidth of band pass	200	Hz	
Description of command				FW vers.
This command determines the bandwidth of the variable band pass filter.				≥ V2.12

CONFigure:AFANalyzer[:PRIMary]:FILTer:WEIGhting *<Weighting>* **CONFigure:AFANalyzer:SECondary:FILTer:WEIGhting *<Weighting>>***				Weighting Filter
<Weighting>	Description of parameters	Def. value	Def. unit	Unit ring
CME | **CCI |** **OFF**	Switch on C-message weighted filter Switch on CCITT weighting filter No weighting filter	OFF	-	Freq.
Description of command				FW vers.
This command selects the weighting filter after the fixed band pass (see Fig. 6-1).				≥ V2.12

CONFigure:AFANalyzer[:PRIMary]:FILTer:BPASs *<Band pass>* Fixed Band Pass Selection
CONFigure:AFANalyzer:SECondary:FILTer:BPASs *<Band pass>*

<Band pass>	Description of parameters	Def. value	Def. unit	Unit ring
	CMU band pass filter with a bandwidth of	BP16	–	
BP01 |	0 Hz to 250 Hz			
BP02 |	6 Hz to 250 Hz			
BP03 |	50 Hz to 250 Hz			
BP04 |	0 Hz to 3000 Hz			
BP05 |	6 Hz to 3000 Hz			
BP06 |	50 Hz to 3000 Hz			
BP07 |	300 Hz to 3000 Hz			
BP08 |	0 Hz to 4000 Hz			
BP09 |	6 Hz to 4000 Hz			
BP10 |	50 Hz to 4000 Hz			
BP11 |	300 Hz to 4000 Hz			
BP12 |	0 Hz to 15000 Hz			
BP13 |	6 Hz to 15000 Hz			
BP14 |	50 Hz to 15000 Hz			
BP15 |	300 Hz to 15000 Hz			
BP16 |	0 Hz to 21000 Hz			
BP17 |	6 Hz to 21000 Hz			
BP18	50 Hz to 21000 Hz			

Description of command	FW vers.
This command selects the first band pass in the AF Analyzer.	≥ V2.12

Subsystem AFANalyzer... (Measured Values)

The subsystem *AFAnalyzer...* contains the commands for reading the results of the audio analysis.

	Scalar Results
READ[:SCALar]:AFANalyzer[:PRIMary]? **READ[:SCALar]:AFANalyzer:SECondary?**	Start single shot meas. and return results
FETCh[:SCALar]:AFANalyzer[:PRIMary]? **FETCh[:SCALar]:AFANalyzer:SECondary?**	Read out meas. results (unsynchronized)
SAMPle[:SCALar]:AFANalyzer[:PRIMary]? **SAMPle[:SCALar]:AFANalyzer:SECondary?**	Read out meas. results (synchron.)

Return	Description of parameters	Def. value	Def. unit	Unit ring
PeakVoltage1	0 V to 42.4 V	NAN	V	
RMSVoltage1	0 V to 30 V	NAN	V	
DCVoltage	–30 V to 30 V	NAN	V	
Distortion	0% to 100%	NAN	%	
PeakVoltage2	0 V to 42.4 V	NAN	V	
RMSVoltage2	0 V to 30 V	NAN	V	
Frequency	10 Hz to 204.8 kHz	NAN	Hz	

Description of command	FW vers.
These commands are always queries. They start a measurement and output all scalar measurement results (see also Fig. 6-1). These are: Peak1 and RMS1 value of AC voltage after first band pass and the weighting filter DC voltage Total harmonic distortion Peak2 and RMS2 value of AC voltage after first band pass and second band pass (variable band pass) Frequency counter	≥ V2.10 ≥ V2.12 (last 3 output values)

Generator Object AFGenerator

The subsystem AFGenerator contains the commands for controlling and configuring the internal AF generator. It corresponds to the measurement softkey *Generator* in the measurement menu *Audio Analyzer/Generator* and the associated input fields.

INITiate:AFGenerator[:PRIMary]		AF Generator Control
INITiate:AFGenerator:SECondary	Start AF generator, reserve resources	⇒ *RUN*
ABORt:AFGenerator:[PRIMary]		
ABORt:AFGenerator:SECondary	Switch off AF generator, release resources	⇒ *OFF*
Description of command		FW vers.
These commands have no query form. They start and stop the AF generator, setting it to the status given in the top right column.		≥ V2.10

FETCh:AFGenerator[:PRIMary]:STATus? **FETCh:AFGenerator:SECondary:STATus?**				Generator Status
Return	Description of parameters	Def. value	Def. unit	Unit ring
OFF |	Generator switched off (`ABORt`, `*RST` or `OFF` due to conflict of resources)	OFF	–	
RUN |	Running (`INITiate`)			
ERR	Switched off (could not be started)			
Description of command				FW vers.
This command is always a query. It returns the current generator status.				≥ V2.10

SOURce:AFGenerator[:PRIMary]:LEVel *<Level>* **SOURce:AFGenerator:SECondary:LEVel *<Level>***				Level (RMS)
<Level>	Description of parameters	Def. value	Def. unit	Unit ring
0 V to 5 V	AF generator voltage	1	V	
Description of command				FW vers.
This command determines the RMS voltage of the AF generator.				≥ V2.10

SOURce:AFGenerator[:PRIMary]:FREQuency *<Frequency>* **SOURce:AFGenerator:SECondary:FREQuency *<Frequency>***				Frequency
<Frequency>	Description of parameters	Def. value	Def. unit	Unit ring
20 Hz to 20 kHz	AF-Generator frequency	1000	Hz	
Description of command				FW vers.
This command determines the AF generator frequency.				≥ V2.10

Test Object MULTitone

The subsystem *MULTitone* measures the level of an audio test signal comprising up to 20 test tones. The subsystem corresponds to the measurement menu *Audio Multitone* and the associated popup menu *Audio Multitone Configuration.*

In analogy to the `AFGenerator` and `AFANalyzer` subsystems reported above, the *Audio Multitone* measurement provides two independent circuits:

- In the first audio channel (subsystem `MULTitone:AF1Channel...`), the audio signals are applied to the connectors AF OUT (output, AF generator signal) and AF IN (input) on the CMU front panel. The first audio channel corresponds to the *Audio Multitone* menu and the associated configuration menu.
- In the second audio channel (subsystem `MULTitone:AF2Channel...`), the audio signals are applied to the connectors AUX 2 (output, AF generator signal) and AUX 1 (input) on the CMU front panel. The secondary audio circuit can not be controlled manually.

With the exception of the input and output connectors, the two audio circuits are identical. All remote control commands are analogous.

Control of Measurement – Subsystem MULTitone

The subsystem *MULTitone* controls the measurement. It corresponds to the softkey *AF Chan. One* in the measurement menu *Audio Multitone* and some of the associated hotkeys.

INITiate:MULTitone:AF1Channel **INITiate:MULTitone:AF2Channel**	Start new measurement	⇒ *RUN*
ABORt:MULTitone:AF1Channel **ABORt:MULTitone:AF2Channel**	Abort running measurement and switch off	⇒ *OFF*
STOP:MULTitone:AF1Channel **STOP:MULTitone:AF2Channel**	Stop measurement after current stat. cycle	⇒ *STOP*
CONTinue:MULTitone:AF1Channel **CONTinue:MULTitone:AF2Channel**	Next measurement step (only *stepping mode*)	⇒ *RUN*
Description of command		FW vers.
These commands have no query form. They start and stop the measurement, setting it to the status indicated in the top right column.		V3.0

CONFigure:MULTitone:AF1Channel:EREPorting *<Mode>* **CONFigure:MULTitone:AF2Channel:EREPorting *<Mode>***				Event Reporting
<Mode>	Description of parameters	Def. value	Def. unit	Unit ring
SRQ | **SOPC |** **SRSQ |** **OFF**	Service request Single operation complete SRQ and SOPC No reporting	OFF	–	–
Description of command				FW vers.
This command defines the events generated when the measurement is terminated or stopped *(event reporting,* see chapter 5).				V3.0

FETCh:MULTitone:AF1Channel:STATus? **FETCh:MULTitone:AF2Channel:STATus?**				Measurement Status
Ret. values	Description of parameters	Def. value	Def. unit	Unit ring
OFF | **RUN |** **STOP |** **ERR |** **STEP |** **RDY,**	Measurement in the *OFF* state (`*RST` or `ABORt`) Running (after `INITiate, CONTinue` or `READ`) Stopped (`STOP`) *OFF* (could not be started) Stepping mode *(<stepmode>=STEP)* Stopped according to repetition mode and stop condition	OFF	–	
1 to 10000 | **NONE**	Counter for current statistics cycle No counting mode set	NONE	–	
Description of command				FW vers.
This command is always a query. It returns the status of the measurement (see chapters 3 and 5).				V3.0

DISPlay:MULTitone:AF1Channel:GRID *<Enable>* **DISPlay:MULTitone:AF2Channel:GRID *<Enable>***				Grid on/off
<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | **OFF**	Switch on grid lines Switch off grid lines	ON	–	
Description of command				FW vers.
This command switches the grid lines in the test diagrams on or off.				V3.0

CONFigure:MULTitone:AF1Channel:RLEVel *<Voltage>* **CONFigure:MULTitone:AF2Channel:RLEVel *<Voltage>***				AF Reference Level
<Voltage>	Description of parameters	Def. value	Def. unit	Unit ring
0.000 V to 5.000 V	Reference Level	0.010	V	
Description of command				FW vers.
This command defines the AF reference level, i.e. the 0-dB line in the test diagram.				V3.0

CONFigure:MULTitone:AF1Channel:RMODe *<Reference>* **CONFigure:MULTitone:AF2Channel:RMODe *<Reference>***				Result
<Result>	Description of parameters	Def. value	Def. unit	Unit ring
RLEV | **TON<nr>**	Results relative to the reference level Results relative to level at test tone <nr>, where <nr> = 1 to 20	TON4	–	
Description of command				FW vers.
This command defines the reference value for the results of the *Audio Multitone* measurement. The reference level is defined via `CONFigure:MULTitone:AF1Channel:RLEVel`. To choose one of the test tones no. 1 to 20, it must be enabled via the `CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>` command.				V3.0

CONFigure:MULTitone:AF1Channel:AFGLead *<Time>* **CONFigure:MULTitone:AF2Channel:AFGLead *<Time>***				AF Generator Lead
<Time>	Description of parameters	Def. value	Def. unit	Unit ring
0 s to 0.1 s	Holdoff time	0.014	s	
Description of command				FW vers.
This command defines a holdoff time for the AF generator.				V3.0

Test Configuration

The commands of the following subsystems configure the *Audio Multitone* measurement. They correspond to the *Audio Multitone Configuration* menu.

Subsystem MULTitone:...CONTrol

The subsystem *MULTitone:...CONTrol* configures the scope of the measurement. It corresponds to the *Control* tab in the popup menu *Audio Multitone Configuration.*

CONFigure:MULTitone:AF1Channel:CONTrol:REPetition **CONFigure:MULTitone:AF2Channel:CONTrol:REPetition** ***<Repetition>, <StopCond>, <Stepmode>***				Test Cycles
<Repetition>	Description of parameters	Def. value	Def. unit	Unit ring
CONTinuous | **SINGleshot |** **1 to 1000,**	Continuous measurement (until `STOP` or `ABORT`) Single shot measurement (until `Status = RDY`) Multiple measurement (*counting*, until `Status = STEP | RDY`)	SING	–	
<StopCond>	Description of parameters	Def. value	Def. unit	Unit ring
SONerror | **NONE,**	Stop measurement in case of error *(stop on error)* Continue measurement even in case of error	NONE	–	
<Stepmode>	Description of parameters	Def. value	Def. unit	Unit ring
STEP | **NONE**	Interrupt measurement after each statistics cycle Continue measurement according to its rep. mode	NONE	–	
Description of command				FW vers.
This command determines the number of statistics cycles, the stop condition and the stepping mode for the measurement. **Note:** *In the case of READ commands (`READ:...`), the <Repetition> parameter has no effect; the measurement is always stopped after a single shot.*				V3.0

Subsystem SUBarrays:MULTitone:...

The subsystem *SUBarrays:MULTitone:...* defines the measurement range and the type of output values.

CONFigure:SUBarrays:MULTitone:AF1Channel
CONFigure:SUBarrays:MULTitone:AF2Channel
<Mode>,<Start>,<Samples>{,<Start>,<Samples>}

Definition of Subarrays

<Mode>	Description of parameters	Def. value	Def. unit	Unit ring
ALL |	Return all measurement values	ALL	–	
ARIThmetical |	Return arithm. mean value in every range			
MINimum |	Return minimum value in every range			
MAXimum |	Return maximum value in every range			
IVAL,	Return single interpolated value at <Start>			
<Start>	Description of parameters	Def. value	Def. unit	Unit ring
1 to 20,	Start test tone in current range	1	–	
<Samples>	Description of parameters	Def. value	Def. unit	Unit ring
1 to 20	Number of test tones in current range	20	–	

Description of command	FW vers.
This command configures the `READ:SUBarrays:MULTitone:AF1Channel...`, `FETCh:SUBarrays:MULTitone:AF1Channel...`, and `SAMPle:SUBarrays:MULTitone:AF1Channel` commands. It restricts the measurement to up to 32 subranges where either all measurement results (the number of which is given by the <Samples> parameter) or a single statistical value is returned. For <Mode> = IVAL, the <Samples> parameter is ignored and the CMU returns a single measurement value corresponding to the abscissa value <Start>. If <Start> is located between two test points with valid results then the result is calculated from the results at these two adjacent test points by linear interpolation. The subranges are subsets of the full range of test tones defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`. Each subrange contains all test tones between the start test tone (test tone no. <Start>) and test tone no. <Start>+<Samples>–1. Test points inside this range that are disabled are not measured (result *NAN)* and do not enter into the ARIThmetical, MINimum and MAXimum values. By default, only one range corresponding to the total measurement range is used and all measurement values are returned.	V3.0

Tolerance values – Subsystem MULTitone:...LIMit

The subsystem *MULTitone:...LIMit* defines tolerance values for the *Audio Multitone* measurement. The subsystem corresponds to the *Limits* tab of the popup menu *Audio Multitone Configuration.*

CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:UPPer
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:UPPer
<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20> Upper Limit, Overall

<Limit_nr>	Description of parameters	Def. value	Def. unit	Unit ring
–80 dB to +80 dB,	Upper limit line at tone <nr>	See below	dB	
<Enable_nr>	Description of parameters	Def. value	Def. unit	Unit ring
ON | OFF	Enable upper limit line at tone <nr>	ON	–	

Description of command	FW vers.
This command configures the upper limit lines and enables the limit check at the 20 test tones that can be defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>.`	V3.0

By default, the limit check is switched on at all tones and the following limit lines apply:

Tone <nr>	**Limit Line/[dB]**	**Enable**	**Tone <nr>**	**Limit Line/[dB]**	**Enable**
1	–9.5	ON	11	+5.6	ON
2	–6.2	ON	12	+6.3	ON
3	–3.8	ON	13	+6.9	ON
4	–1.9	ON	14	+7.5	ON
5	–0.3	ON	15	+8.0	ON
6	+1.0	ON	16	+8.6	ON
7	+2.1	ON	17	+9.1	ON
8	+3.1	ON	18	+9.6	ON
9	+4.0	ON	19	+10.0	ON
10	+4.8	ON	20	+10.5	ON

CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE:ASYMmetric:UPPer
CONFigure:MULTitone:AF2Channel:TONE<nr>:LIMit:LINE:ASYMmetric:UPPer
<Limit>, <Enable> Upper Limit, Single Point

<Limit>	Description of parameters	Def. value	Def. unit	Unit ring
–80 dB to +80 dB,	Upper limit line at tone <nr>	See below	dB	
<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | OFF	Enable upper limit line at tone <nr>	ON	–	

Description of command	FW vers.
This command configures the upper limit and enables the limit check at one of 20 test tones that can be defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`. The test tones are numbered by <nr> = 1 to 20. The default limits at all test points are quoted in the previous command.	V3.0

CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:LOWer
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:LOWer
<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20> Lower Limits, Overall

<Limit_nr>	Description of parameters	Def. value	Def. unit	Unit ring
–80 dB to +80 dB,	Lower limit line at tone <nr>	See below	dB	
<Enable_nr>	Description of parameters	Def. value	Def. unit	Unit ring
ON | OFF	Enable lower limit line at tone <nr>	ON	–	

Description of command	FW vers.
This command configures the lower limit lines and enables the limit check at the 20 test tones that can be defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`.	V3.0

By default, the limit check is switched on at all tones and the following limit lines apply:

Tone <nr>	Limit Line/[dB]	Enable	Tone <nr>	Limit Line/[dB]	Enable
1	–13.5	ON	11	+1.6	ON
2	–10.2	ON	12	+2.3	ON
3	–7.8	ON	13	+3.9	ON
4	–5.9	ON	14	+3.5	ON
5	–4.3	ON	15	+4.0	ON
6	–3.0	ON	16	+4.6	ON
7	–1.9	ON	17	+5.0	ON
8	–0.9	ON	18	+5.0	ON
9	0.0	ON	19	+5.0	ON
10	+0.8	ON	20	+5.0	ON

CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE:ASYMmetric:LOWer
CONFigure:MULTitone:AF2Channel:TONE<nr>:LIMit:LINE:ASYMmetric:LOWer
<Limit>, <Enable> Lower Limit, Single Point

<Limit>	Description of parameters	Def. value	Def. unit	Unit ring
–80 dB to +80 dB,	Lower limit line at tone <nr>	See below	dB	
<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | OFF	Enable lower limit line at tone <nr>	ON	–	

Description of command	FW vers.
This command configures the lower limit and enables the limit check at one of 20 test tones that can be defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`. The test tones are numbered by <nr> = 1 to 20. The default limits at all test points are quoted in the previous command.	V3.0

DEFault:MULTitone:AF1Channel:LIMit:LINE *<Enable>* Default Settings
DEFault:MULTitone:AF2Channel:LIMit:LINE *<Enable>*

<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	

Description of command	FW vers.
If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting OFF results in an error message). If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.	V3.0

DEFault:MULTitone:LIMit:LINE *<Enable>* Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | OFF	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	

Description of command	FW vers.
If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem (including `AF1Channel` and `AF2Channel`) to their default values (the setting OFF results in an error message). If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF).*	V3.0

Test Tones – Subsystem MULTitone:...TDEFinition

The subsystem *MULTitone:...TDEFinition* configures the audio test signal used for the *Audio Multitone* measurement. The subsystem corresponds to the *Tone Def.* tab of the popup menu *Audio Multitone Configuration.*

CONFigure:MULTitone:AF1Channel:TDEFinition Test Tones
CONFigure:MULTitone:AF2Channel:TDEFinition
<Freq_1>, <Lev_1>, <Enable_1>, ... <Freq_20>, <Lev_20>, <Enable_20>

<Freq_nr>	Description of parameters	Def. value	Def. unit	Unit ring
10 Hz to 15999 Hz,	Frequency of test tone <nr>	See below	Hz	
<Lev_nr>	Description of parameters	Def. value	Def. unit	Unit ring
0.0 V to 5.0 V,	Level at test tone <nr>	See below	V	0
<Enable_nr>	Description of parameters	Def. value	Def. unit	Unit ring
ON | OFF	Switch on / off test tone <nr>	See below	–	

Description of command	FW vers.
This command enables and configures up to 20 test tones. The minimum frequency spacing between two tones is 1 Hz. The sum of all test tones must not exceed the maximum AF generator level quoted in the data sheet.	V3.0

The following default test tones are provided:

Tone <nr>	Frequency/[Hz]	Level/[V]	Enable	Tone <nr>	Frequency/[Hz]	Level/[V]	Enable
1	300	0.01	ON	11	1700	0.01	ON
2	440	0.01	ON	12	1840	0.01	ON
3	580	0.01	ON	13	1980	0.01	ON
4	720	0.01	ON	14	2120	0.01	ON
5	860	0.01	ON	15	2260	0.01	ON
6	1004	0.01	ON	16	2400	0.01	ON
7	1140	0.01	ON	17	2540	0.01	ON
8	1280	0.01	ON	18	2680	0.01	ON
9	1420	0.01	ON	19	2820	0.01	ON
10	1560	0.01	ON	20	3000	0.01	ON

CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>
CONFigure:MULTitone:AF2Channel:TDEFinition:TONE<nr>
<Frequency>, <Deviation>, <Enable>

Test Tones

<Frequency>	Description of parameters	Def. value	Def. unit	Unit ring
10 Hz to 15999 Hz,	Frequency of test tone <nr>	See below	Hz	
<Level>	Description of parameters	Def. value	Def. unit	Unit ring
0.0 V to 5.0 V,	AF level test tone <nr>	See below	V	0
<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | OFF	Switch on / off test tone <nr>	See below	–	

Description of command	FW vers.
This command enables and configures one of up to 20 test tones (<nr> = 1 to 20). The default values for all test tones are given in the previous command.	V3.0

CONFigure:MULTitone:AF1Channel:TDEFinition:MODE *<Mode>*
CONFigure:MULTitone:AF2Channel:TDEFinition:MODE *<Mode>*

Level Selection

<Mode>	Description of parameters	Def. value	Def. unit	Unit ring
SEParate | **TLEV**	Use separate levels for each tone Use total level	SEParate	–	–

Description of command	FW vers.
This command defines how the voltage of each of the test tones is determined. • In the default setting SLEV, the levels of all tones are defined separately and may differ from each other (see command `CONFigure:MULTitone:...:TDEFinition` above). • In the setting `TLEV`, the total AF generator level of 200 mV (see command `CONFigure:MULTitone:...:TDEFinition:TLEVel` below) is evenly distributed among all 20 enabled test tones.	V3.0

CONFigure:MULTitone:AF1Channel:TDEFinition:TLEVel *<Total_Level>*
CONFigure:MULTitone:AF2Channel:TDEFinition:TLEVel *<Total_Level>*

Total Level

<Total_Level>	Description of parameters	Def. value	Def. unit	Unit ring
0.0 V to 5.0 V	Total level/voltage (sum of all test tones)	0.200	V	

Description of command	FW vers.
This command defines the total AF generator level that is evenly distributed among all enabled test tones. The total level setting comes into effect after the level selection mode is set to `TLEV` (see `CONFigure:MULTitone:...TDEFinition:MODe` command above). The total level must not exceed the maximum AF generator level quoted in the data sheet.	V3.0

CONFigure:MULTitone:AF1Channel:TDEFinition:DEFault *<Enable>* **CONFigure:MULTitone:AF2Channel:TDEFinition:DEFault *<Enable>***				Default Settings
<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	
Description of command				FW vers.
If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting OFF results in an error message). If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.				V3.0

CONFigure:MULTitone:TDEFinition:DEFault *<Enable>*				Default Settings
<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	
Description of command				FW vers.
If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem (including `AF1Channel` and `AF2Channel`) to their default values (the setting OFF results in an error message). If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.				V3.0

Path Configuration – Subsystem MULTitone:AF1Channel:FILTer

The subsystem *MULTitone:AF1Channel:FILTer* configures the voice-processing equipment used for the *Audio Multitone* measurement. The subsystem corresponds to the *Filters* tab of the popup menu *Audio Multitone Configuration.*

CONFigure:MULTitone:AF1Channel:FILTer:BPASs:DCCoupling
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:DCCoupling
<Bandpass>

Bandpass, DC Coupling

<Bandpass>	Description of parameters	Def. value	Def. unit	Unit ring
	CMU band pass filter with a bandwidth of	BP16	–	
BP01 |	0 Hz to 250 Hz			
BP02 |	6 Hz to 250 Hz			
BP03 |	50 Hz to 250 Hz			
BP04 |	0 Hz to 3000 Hz			
BP05 |	6 Hz to 3000 Hz			
BP06 |	50 Hz to 3000 Hz			
BP07 |	300 Hz to 3000 Hz			
BP08 |	0 Hz to 4000 Hz			
BP09 |	6 Hz to 4000 Hz			
BP10 |	50 Hz to 4000 Hz			
BP11 |	300 Hz to 4000 Hz			
BP12 |	0 Hz to 15000 Hz			
BP13 |	6 Hz to 15000 Hz			
BP14 |	50 Hz to 15000 Hz			
BP15 |	300 Hz to 15000 Hz			
BP16 |	0 Hz to 21000 Hz			
BP17 |	6 Hz to 21000 Hz			
BP 18	50 Hz to 21000 Hz			

Description of command	FW vers.
This command selects the bandpass filter to be used if the AF path coupling is set to DC (see `CONFigure:AFANalyzer[:PRIMary]:CONTrol:COUPling` command).	V3.0

CONFigure:MULTitone:AF1Channel:FILTer:BPASs:ACCoupling
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:ACCoupling
<Bandpass>

Bandpass, AC Coupling

<Bandpass>	Description of parameters	Def. value	Def. unit	Unit ring
	CMU band pass filter with a bandwidth of	BP17	–	
BP02 |	6 Hz to 250 Hz			
BP03 |	50 Hz to 250 Hz			
BP05 |	6 Hz to 3000 Hz			
BP06 |	50 Hz to 3000 Hz			
BP07 |	300 Hz to 3000 Hz			
BP09 |	6 Hz to 4000 Hz			
BP10 |	50 Hz to 4000 Hz			
BP11 |	300 Hz to 4000 Hz			
BP13 |	6 Hz to 15000 Hz			
BP14 |	50 Hz to 15000 Hz			
BP15 |	300 Hz to 15000 Hz			
BP17 |	6 Hz to 21000 Hz			
BP18	50 Hz to 21000 Hz			

Description of command	FW vers.
This command selects the bandpass filter to be used if the AF path coupling is set to AC (see `CONFigure:AFANalyzer[:PRIMary]:CONTrol:COUPling` command).	V3.0

CONFigure:MULTitone:AF1Channel:FILTer:WEIGhting *<Weighting>*
CONFigure:MULTitone:AF2Channel:FILTer:WEIGhting *<Weighting>* Weighting

<Weighting>	Description of parameters	Def. value	Def. unit	Unit ring
CME | **CCI |** **OFF**	Switch on C-message weighted filter Switch on CCITT weighting filter No weighting filter	OFF	–	

Description of command	FW vers.
This command selects the weighting filter to be included in the AF input signal path.	V3.0

DEFault:MULTitone:AF1Channel:FILTer *<Enable>*
DEFault:MULTitone:AF2Channel:FILTer *<Enable>* Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	

Description of command	FW vers.
If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem to their default values (the setting OFF results in an error message). If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.	V3.0

DEFault:MULTitone:FILTer *<Enable>* Default Settings

<Enable>	Description of parameters	Def. value	Def. unit	Unit ring
ON | **OFF**	The parameters are set to their default values Some or all parameters differ from the default values	ON	–	

Description of command	FW vers.
If used as a setting command with the parameter *ON* this command sets all parameters of the subsystem (including `AF1Channel` and `AF2Channel`) to their default values (the setting OFF results in an error message). If used as a query the command returns whether all parameters are set to their default values *(ON)* or not *(OFF)*.	V3.0

Measured Values – Subsystem MULTitone:...?

The subsystem *MULTitone:...?* measures the AF input level, returns the results and compares them with the tolerance values. The subsystem corresponds to the various output elements in the measurement menu *Audio Multitone.*

READ[:SCALar]:MULTitone:AF1Channel:TONE<nr>? Audio Multitone Results
READ[:SCALar]:MULTitone:AF2Channel:TONE<nr>?
Start single shot measurement and return results ⇒ *RUN*
FETCh[:SCALar]:MULTitone:AF1Channel:TONE<nr>?
FETCh[:SCALar]:MULTitone:AF2Channel:TONE<nr>? Read results (unsynchronized) ⇒ *RUN*
SAMPle[:SCALar]:MULTitone:AF1Channel:TONE<nr>?
SAMPle[:SCALar]:MULTitone:AF2Channel:TONE<nr>? Read results (synchronized) ⇒ *RUN*

Returned values	Description of parameters	Def. value	Def. unit	Unit ring
–100.0 dB to +20.0 dB	AF response at point <nr>	NAN	dB	

Description of command	FW vers.
These commands are always queries. They return the audio level at test tones <nr> (<nr> = 1 to 20) defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`.	V3.0

Audio Multitone Results
READ:ARRay:MULTitone:AF1Channel? Start single shot measurement and return results ⇒ *RUN*
READ:ARRay:MULTitone:AF2Channel?
FETCh:ARRay:MULTitone:AF1Channel? Read meas. results (unsynchronized) ⇒ *RUN*
FETCh:ARRay:MULTitone:AF2Channel?
SAMPle:ARRay:MULTitone:AF1Channel? Read results (synchronized) ⇒ *RUN*
SAMPle:ARRay:MULTitone:AF2Channel?

Returned values	Description of parameters	Def. value	Def. unit	Unit ring
–100.0 dB to +20.0 dB,	FreqResp[1], 1st value for AF response	NAN	dB	
...	...	...	...	
–100.0 dB to +20.0 dB	FreqResp[20], 20th value for AF resp.	NAN	dB	

Description of command	FW vers.
These commands are always queries. They return the audio level at the 20 test tones defined via `CONFigure:MULTitone:AF1Channel:TONE<nr>`.	V3.0

READ:SUBarrays:MULTitone:AF1Channel? Subarray Results
Start single shot measurement and return results ⇒ *RUN*
READ:SUBarrays:MULTitone:AF2Channel?
FETCh:SUBarrays:MULTitone:AF1Channel? Read meas. results (unsynchronized) ⇒ *RUN*
FETCh:SUBarrays:MULTitone:AF2Channel?
SAMPle:SUBarrays:MULTitone:AF1Channel? Read results (synchronized) ⇒ *RUN*
SAMPle:SUBarrays:MULTitone:AF2Channel?

Ret. values per subrange	Description of parameters	Def. value	Def. unit	Unit ring
–100.0 dB to +20.0 dB,	FreqResp[1], 1st value for AF response	NAN	dB	
...	...	...	...	
–100.0 dB to +20.0 dB	FreqResp[n], nth value for AF response	NAN	dB	

Description of command	FW vers.
These commands are always queries. They return the audio level in the subranges defined by means of the `CONFigure:SUBarrays:MULTitone:AF1Channel` command. In the default setting of the configuration command the `READ:SUBarrays...`, `FETCh:SUBarrays...`, and `SAMPle:SUBarrays...` command group is equivalent to the `READ:ARRay...`, `FETCh:ARRay...`, and `SAMPle:ARRay...` command group described above. The `CONFigure:SUBarrays:MULTitone:AF1Channel` command defines a maximum of 32 subranges. If one of the statistical modes `(ARIThmetical, MINimum, MAXimum)` or `IVAL` is set, only one value is returned by subrange.	V3.0

CALCulate[:SCALar]:MULTitone:AF1Channel:TONE<nr>:MATChing:LIMit? Limit Matching
CALCulate[:SCALar]:MULTitone:AF2Channel:TONE<nr>:MATChing:LIMit?

Returned result	Value range	Def. value	Def. unit	Unit ring
Limit matching at tone <nr>	**NMAU | NMAL | INV | OK**	INV	–	

Description of command	FW vers.
This command is always a query. It indicates whether and in which way the error limits at tone <nr> (<nr> = 1 to 20) have been exceeded. The following messages may be return for all measured values:	V3.0

NMAU	Underflow of tolerance value	*not matching, underflow*
NMAL	Tolerance value exceeded	*not matching, overflow*
INV	Measurement invalid	*invalid*
OK	all tolerances matched	

CALCulate[:SCALar]:MULTitone:AF1Channel:MATChing:LIMit? Limit Matching, Overall
CALCulate[:SCALar]:MULTitone:AF2Channel:MATChing:LIMit?

Returned result	Value range	Def. value	Def. unit	Unit ring
Limit matching at tone <nr>	**NMAU | NMAL | INV | OK**	INV	–	

Description of command	FW vers.
This command is always a query. It indicates whether and in which way the error limits at tone <nr> (<nr> = 1 to 20) have been exceeded. The returned messages are the same as in the previous command.	V3.0

CALCulate:ARRay:MULTitone:AF1Channel:MATChing:LIMit? Limit Matching, Overall
CALCulate:ARRay:MULTitone:AF2Channel:MATChing:LIMit?

Returned result	Value range	Def. value	Def. unit	Unit ring
20 bit field,	Indicator for upper limit matching at tone 1 to 20	NAN	–	
20 bit field	Indicator for lower limit matching at tone 1 to 20	NAN	–	

Description of command	FW vers.
This command is always a query. Any set bit of the two returned fields indicates that the limits at the corresponding point are exceeded.	V3.0

List of Commands

In the following, all remote-control commands of function group *RF Non-Signalling* implemented in the CMU will be listed with their parameters and page numbers. Generally, they are arranged alphabetically according to the **second** keyword of the command so that related commands belong to the same group. For a list of common commands see Table 6-1 on page 6.1.

Table 6-2 List of remote-control commands: CMU base system

Command	Parameters	Remarks	Page
Subsystem COMMunicate (interface parameters)			
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	0 to 30	with query	6.13
SYSTem:COMMunicate:SERial<1|2>:APPLication	–	query only	6.13
SYSTem:COMMunicate:SERial<1|2>:TRANsmit:PACE	XON|ACK|NONE	with query	6.14
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD	110 to 19200	with query	6.13
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITs	7|8	with query	6.14
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PARIty[:TYPE]	NONE|ODD|EVEN	with query	6.14
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:STOP	1|2	with query	6.14
Subsystem ERRor (error queue)			
SYSTem:ERRor?		query only	6.5
Subsystem MISC (keyboard settings)			
SYSTem:MISC:KBEep	ON|OFF	with query	6.16
SYSTem:MISC:KEYBoard	US|GR	with query	6.16
Subsystem MQueue (measurement queue)			
SYSTem:MQUeue[:COMPlete]:ITEM?	US|GR	query only	6.17
SYSTem:MQUeue[:COMPlete][:LIST]?	<Meas_Queue>	query only	6.17
Subsystem NONVolatile (disable nonvolatile RAM)			
SYSTem:NONVolatile:DISable		no query	6.5
Subsystem OPTions (options)			
SYSTem:OPTions:INFO?		query only	6.14
SYSTem:OPTions?		query only	6.15
Subsystem PRESet (general reset)			
SYSTem:PRESet		no query	6.17
Subsystem REMote (remote control)			
SYSTem:REMote:ADDRess:PRIMary	0 to 30	with query	6.12
SYSTem:REMote:ADDRess:SECondary	1 to 30,<Remote-FGrp-Name> | NONe	with query	6.12
*SEC	0 to 30		6.13
System STATus (status reporting system)			
STATus:OPERation:CMU:CLEar	–	no query	6.9
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:CONDition?		query only	6.8
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:ENABle	0 to 32767	with query	6.9
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:NTRansition	0 to 32767	with query	6.8
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:PTRansition	0 to 32767	with query	6.8

Command	Parameters	Remarks	Page
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>[EVENt]?		query only	6.8
STATus:OPERation:CMU:SUM<nr>:CONDition?		query only	6.7
STATus:OPERation:CMU:SUM<nr>:ENABle	0 to 32767	with query	6.8
STATus:OPERation:CMU:SUM<nr>:NTRansition	0 to 32767	with query	6.7
STATus:OPERation:CMU:SUM<nr>:PTRansition	0 to 32767	with query	6.7
STATus:OPERation:CMU:SUM<nr>[EVENt]?		query only	6.7
STATus:OPERation:CONDition?		query only	6.6
STATus:OPERation:ENABle	0 to 32767	with query	6.7
STATus:OPERation:EVENt:SADDress?	<SecAddr>,<Fgrp>	query only	6.11
STATus:OPERation:NTRansition	0 to 32767	with query	6.6
STATus:OPERation:PTRansition	0 to 32767	with query	6.6
STATus:OPERation:SYMBolic:ENABle	<Event>{,<Event>}	with query	6.11
STATus:OPERation:SYMBolic[:EVENt]?	NONE | <Event>{,<Event>}	query only	6.11
STATus:OPERation[EVENt]?		query only	6.6
STATus:PRESet	–	no query	6.10
STATus:QUEStionable:CONDition?		query only	6.9
STATus:QUEStionable:ENABle	0 to 32767	with query	6.10
STATus:QUEStionable:NTRansition	0 to 32767	with query	6.10
STATus:QUEStionable:PTRansition	0 to 32767	with query	6.10
STATus:QUEStionable[EVENt]?		query only	6.9
STATus:QUEStionable[EVENt]?		query only	6.8
Subsystem SYNChronize (Reference frequency)			
CONFigure:SYNChronize:FREQuency:REFerence CONFigure:SYNChronize:FREQuency:REFerence:MODE	10 kHz to 52 MHz INTernal | EXTernal	with query with query	6.18 6.18
Subsystem TIMe (system time)			
SYSTem:TIMe:DATe	YYYY,MM,DD	with query	6.16
SYSTem:TIMe:TZONe SYSTem:TIMe[:TIMe]	-12 to +12,-59 to +59 0 to 23,0 to 59,0 to 59	with query with query	6.15 6.15
Subsystem Version (firmware version)			
SYSTem:VERSion?		query only	6.4

Table 6-3 List of remote-control commands: RF measurements

Command	Parameters	Remarks	Page
Subsystem CORRection:LOSS (Ext. Attenuation)			
[SENSe:]CORRection:LOSS:INPut<nr>[:MAGNitude]	–50 dB to 50 dB	with query	6.29
SOURce:CORRection:LOSS:INPut<nr>[:MAGNitude]	–50 dB to 50 dB	with query	6.29
[SENSe:]CORRection:LOSS:OUTPut<nr>[:MAGNitude]	–50 dB to 50 dB	with query	6.30
SOURce:CORRection:LOSS:OUTPut<nr>[:MAGNitude]	–50 dB to 50 dB	with query	6.30
Subsystem DM:CLOCk (Synchronization)			
SOURce:DM:CLOCk:FREQuency	1.219 MHz to 39.000 MHz	with query	6.30

Command	Parameters	Remarks	Page
SOURce:DM:CLOCk:STATe	ON | OFF	with query	6.30
Subsystem LEVel (Input Level)			
[SENSe:]LEVel:ATTenuation	NORMal | LNOise | LDIStortion	with query	6.19
[SENSe:]LEVel:MAXimum	–37 dBm to +53 dBm	depending on input and ext. attenuation set	6.19
[SENSe:]LEVel:MODE	MANual | AUTO	with query	6.19
[SENSe:]LEVel:REFerence	–100 dBm to +53 dBm	depending on input and ext. attenuation set	6.20
Test object POWer (Power vs. Time)			
INITiate:POWer	–	no query	6.31
ABORt:POWer	–	no query	6.31
STOP:POWer	–	no query	6.31
CONFigure:SUBarrays:POWer	ALL | ARIThmetical | MINimum | MAXimum | IVAL,<Start>,<Samples>{,<Start>,<Samples>}	with query	6.35
CONFigure:POWer:CONTrol	SCALar | ARRay	with query	6.32
DISPlay:POWer:CONTrol:GRID	ON | OFF	with query	6.32
CONFigure:POWer:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, NONE,STEP | NONE	with query	6.32
CONFigure:POWer:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.31
[SENSe:]POWer:FREQuency:BANDwidth[:RESolution]	10 Hz to 1 MHz	with query	6.33
[SENSe:]POWer:FREQuency:BWIDth[:RESolution]	10 Hz to 1 MHz	with query	6.33
[SENSe:]POWer:FREQuency:CENTer	10 kHz to 2.7 GHz	with query	6.33
[SENSe:]POWer:LEVel:RANGe	10 dB to 100 dB	with query	6.33
READ:SUBarrays:POWer:MINimum?	–100.0 dB to +20.0 dB	query only	6.36
FETCh:SUBarrays:POWer:MINimum?	–100.0 dB to +20.0 dB	query only	6.36
SAMPle:SUBarrays:POWer:MINimum?	–100.0 dB to +20.0 dB	query only	6.36
FETCh:POWer:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 0 to 10000 | NONE , 0 to 1000 | NONE	query only	6.31
[SENSe:]POWer:TIME:DELay	-1000.0 µs to +1000.0 µs	depending on span and bandwidth	6.34
[SENSe:]POWer:TIME:SPAN	10 µs to 10 s	depending on bandwidth	6.34
READ:ARRAy:POWer[:CURRent]?	–128.0 dBm to +47.0 dBm	query only	6.36
READ:SUBarrays:POWer[:CURRent]?	–100.0 dB to +20.0 dB	query only	6.36
FETCh:SUBarrays:POWer[:CURRent]?	–100.0 dB to +20.0 dB	query only	6.36
SAMPle:SUBarrays:POWer[:CURRent]?	–100.0 dB to +20.0 dB	query only	6.36
Test object RFANalyzer (Power)			
SAMPle:SUBarrays:POWer[:CURRent]?	–100.0 dB to +20.0 dB	query only	6.36
INITiate:RFANalyzer	–	no query	6.23
ABORt:RFANalyzer	–	no query	6.23
STOP:RFANalyzer	–	no query	6.23
CONTinue:RFANalyzer	–	no query	6.23

Command	Parameters	Remarks	Page
[SENSe:]RFANalyzer:BANDwidth[:RESolution]	10 Hz to 1 MHz | WIDE	with query	6.22
[SENSe:]RFANalyzer:BWIDth[:RESolution]	10 Hz to 1MHz | WIDE	with query	6.22
CONFigure:RFANalyzer:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, NONE,STEP | NONE	with query	6.24
CONFigure:RFANalyzer:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.23
[SENSe:]RFANalyzer:FREQuency	100 kHz to 2.7 GHz	with query	6.22
CONFigure:RFANalyzer:POWer:RTIMe	0 to xxx	with query	6.24
READ[:SCALar]:RFANalyzer:POWer?	-120.0 dBm to +47.0 dBm	query only	6.24
SAMPle[:SCALar]:RFANalyzer:POWer?	-120.0 dBm to +47.0 dBm	query only	6.24
FETCh:RFANalyzer:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 0 to 10000 | NONE , 0 to 1000 | NONE	query only	6.23
Generator object RFGenerator			
INITiate:RFGenerator	–	no query	6.25
ABORt:RFGenerator	–	no query	6.25
SOURce:RFGenerator:BANDwidth	OFF | F30Khz | F300khz	with query	6.28
SOURce:RFGenerator:BWIDth	<Bandwidth>	with query	6.28
SOURce:RFGenerator:FHOPping	100.0 kHz to 2.7 GHz	with query	6.27
SOURce:RFGenerator:FHOPping:FREQuency:MODE	ABSolute | RELative	with query	6.27
SOURce:RFGenerator:FHOPping:STATe	OFF | ON	with query	6.27
SOURce:RFGenerator:FREQuency	100.0 kHz to 2.7 GHz	with query	6.26
SOURce:RFGenerator:LEVel	-137.0 dBm to + 13.0 dBm	restricted for RF1 / 2	6.25
SOURce:RFGenerator:MODulation	OFF | SSB | AM	with query	6.26
SOURce:RFGenerator:MODulation:AM:INDex	0% to 100%	with query	6.27
SOURce:RFGenerator:MODulation:SSB:FREQuency	-300 kHz to +300 kHz	with query	6.26
SOURce:RFGenerator:PULSe:STATe	OFF | ON	with query	6.28
FETCh:RFGenerator:STATus?	OFF | RUN | ERR	query only	6.25
Subsystem TRIGger			
TRIGger[:SEQuence]:DEFault	ON | OFF	with query	6.21
TRIGger[:SEQuence]:SLOPe	POSitive | NEGative	with query	6.20
TRIGger[:SEQuence]:SOURce	IMMediate | RFPower | IFPower | EXTern	with query	6.20
TRIGger[:SEQuence]:THReshold	LOW | MEDium | HIGH	with query	6.20
Test object SPECtrum			
INITiate:SPECtrum	–	no query	6.37
ABORt:SPECtrum	–	no query	6.37
STOP:SPECtrum	–	no query	6.37
CONFigure:SUBarrays:SPECtrum	ALL | ARIThmetical | MINimum | MAXimum | IVAL,<Start>,<Samples>{,<Start>,<Samples>}	with query	6.40
CONFigure:SPECtrum:CONTrol	SCALar | ARRay	with query	6.38
DISPlay:SPECtrum:CONTrol:GRID	ON | OFF	with query	6.38
CONFigure:SPECtrum:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, NONE, STEP | NONE	with query	6.38

Command	Parameters	Remarks	Page
CONFigure:SPECtrum:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.37
[SENSe:]SPECtrum:FREQuency:BANDwidth[:RESolution]	10 Hz to 1 MHz | AUTO	with query	6.39
[SENSe:]SPECtrum:FREQuency:BWIDth[:RESolution]	10 Hz to 1 MHz | AUTO	with query	6.39
[SENSe:]SPECtrum:FREQuency:CENTer	10.000005 MHz to 2.699999995 GHz	with query	6.39
[SENSe:]SPECtrum:FREQuency:SPAN	0.00001 MHz to 2.69999999 GHz	with query	6.39
[SENSe:]SPECtrum:FREQuency:STARt	10 MHz to 2.69999999 GHz	with query	6.39
[SENSe:]SPECtrum:FREQuency:STOP	10.00001 MHz to 2.7 GHz	with query	6.39
[SENSe:]SPECtrum:LEVel:RANGe	10 dB to 100 dB	with query	6.39
READ:SUBarrays:SPECtrum:MINimum?	–100.0 dB to +20.0 dB	query only	6.41
FETCh:SUBarrays:SPECtrum:MINimum?	–100.0 dB to +20.0 dB	query only	6.41
SAMPle:SUBarrays:SPECtrum:MINimum?	–100.0 dB to +20.0 dB	query only	6.41
FETCh:SPECtrum:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 0 to 10000 | NONE , 0 to 1000 | NONE	query only	6.37
FETCh:ARRAy:SPECtrum[:CURRent]?	–120.0 dBm to +47.0 dBm	query only	6.41
SAMPle:ARRAy:SPECtrum[:CURRent]?	–120.0 dBm to +47.0dBm	query only	6.41
READ:SUBarrays:SPECtrum[:CURRent]?	–100.0 dB to +20.0 dB	query only	6.41
FETCh:SUBarrays:SPECtrum[:CURRent]?	–100.0 dB to +20.0 dB	query only	6.41
SAMPle:SUBarrays:SPECtrum[:CURRent]?	–100.0 dB to +20.0 dB	query only	6.41
Subsystem INPut, OUTput (➲)			
INPut[:STATe]	ON | OFF	with query	6.29
OUTPut[:STATe]	ON | OFF	with query	6.29

Table 6-4 List of remote-control commands: Audio Measurements

Command	Parameters	Remarks	Page
Subsystem AFANalyzer			
INITiate:AFANalyzer:SECondary	–	no query	6.43
STOP:AFANalyzer:SECondary	–	no query	6.43
STOP:AFANalyzer:SECondary	–	no query	6.43
ABORt:AFANalyzer:SECondary	–	no query	6.43
CONTinue:AFANalyzer:SECondary	–	no query	6.43
CONFigure:AFANalyzer:SECondary:CONTrol:COUPling	AC | DC	with query	6.45
CONFigure:AFANalyzer:SECondary:CONTrol:DIStortion[:FREQuency]	100 Hz to 10000 Hz	with query	6.45
CONFigure:AFANalyzer:SECondary:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, SONerror | NONE, STEP | NONE	with query	6.45
CONFigure:AFANalyzer:SECondary:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.43
CONFigure:AFANalyzer:SECondary:FILTer:BPASs	BP01 to BP18	with query	6.47
CONFigure:AFANalyzer:SECondary:FILTer:VBPass:BWIDth	10 Hz to 1000 Hz	with query	6.46
CONFigure:AFANalyzer:SECondary:FILTer:VBPass:CFRequency	20 Hz to 20000 Hz	with query	6.46

Command	Parameters	Remarks	Page
CONFigure:AFANalyzer:SECondary:FILTer:WEIGhting	CME | CCI | OFF	with query	6.46
CONFigure:AFAnalyzer:SECondary:MTReduce	LOWF | EXPF, <Frequency>	with query	6.44
FETCh:AFAnalyzer:SECondary:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 1 to 10000 | NONE	query only	6.44
READ[:SCALar]:AFANalyzer:SECondary?	–	query only	6.47
FETCh[:SCALar]:AFANalyzer:SECondary?	–	query only	6.47
SAMPle[:SCALar]:AFANalyzer:SECondary?	–	query only	6.47
INITiate:AFANalyzer[:PRIMary]	–	no query	6.43
ABORt:AFANalyzer[:PRIMary]	–	no query	6.43
CONTinue:AFANalyzer[:PRIMary]	–	no query	6.43
CONFigure:AFANalyzer[:PRIMary]:CONTrol:COUPling	AC | DC	with query	6.45
CONFigure:AFANalyzer[:PRIMary]:CONTrol:DISTortion[:FREQuency]	100 Hz to 10000 Hz	with query	6.45
CONFigure:AFANalyzer[:PRIMary]:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 10000, SONerror | NONE, STEP | NONE	with query	6.45
CONFigure:AFANalyzer[:PRIMary]:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.43
CONFigure:AFANalyzer[:PRIMary]:FILTer:BPASs	BP01 to BP18	with query	6.47
CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:BWIDth	10 Hz to 1000 Hz	with query	6.46
CONFigure:AFANalyzer[:PRIMary]:FILTer:VBPass:CFRequency	20 Hz to 20000 Hz	with query	6.46
CONFigure:AFANalyzer[:PRIMary]:FILTer:WEIGhting	CME | CCI | OFF	with query	6.46
CONFigure:AFAnalyzer[:PRIMary]:MTReduce	LOWF | EXPF, <Frequency>	query only	6.44
FETCh:AFAnalyzer[:PRIMary]:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 1 to 10000 | NONE	query only	6.44
READ[:SCALar]:AFANalyzer[:PRIMary]?	–	query only	6.47
Subsystem AFGenerator			
INITiate:AFGenerator:SECondary	–	no query	6.48
ABORt:AFGenerator:SECondary	–	no query	6.48
SOURce:AFGenerator:SECondary:FREQuency	20 Hz to 20 kHz	with query	6.48
SOURce:AFGenerator:SECondary:LEVel	0 µV to 5 V	with query	6.48
FETCh:AFGenerator:SECondary:STATus?	OFF | RUN | ERR	query only	6.48
INITiate:AFGenerator[:PRIMary]	–	no query	6.48
ABORt:AFGenerator[:PRIMary]	–	no query	6.48
SOURce:AFGenerator[:PRIMary]:FREQuency	20 Hz to 20 kHz	with query	6.48
SOURce:AFGenerator[:PRIMary]:LEVel	0 µV to 5 V	with query	6.48
FETCh:AFGenerator[:PRIMary]:STATus?	OFF | RUN | ERR	query only	6.48
Subsystem AFLevel AF input evel)			
[SENSe:]AFLevel:DEFault	ON | OFF	with query	6.43
[SENSe:]AFLevel:MAXimum	<Level>	with query	6.42
[SENSe:]AFLevel:MODE	MANual | AUTO	with query	6.42
Subsystem MULTitone			
INITiate:MULTitone:AF1Channel	–	no query	6.49
ABORt:MULTitone:AF1Channel	–	no query	6.49
STOP:MULTitone:AF1Channel	–	no query	6.49
CONTinue:MULTitone:AF1Channel	–	no query	6.49

Command	Parameters	Remarks	Page
CONFigure:SUBarrays:MULTitone:AF1Channel	ALL | ARITHmetical | MINimum | MAXimum | IVAL,<Range>{,<Range>}	with query	6.52
CONFigure:MULTitone:AF1Channel:AFGLead	0 s to 0.1 s	with query	6.51
CONFigure:MULTitone:AF1Channel:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 1000, SONerror | NONE, STEP | NONE	with query	6.51
CONFigure:MULTitone:AF1Channel:CONTrol:TDEFinition	ON | OFF	with query	6.57
CONFigure:MULTitone:AF1Channel:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.49
DEFault:MULTitone:AF1Channel:FILTer	ON | OFF	with query	6.59
CONFigure:MULTitone:AF1Channel:FILTer:BPASs:ACCoupling	*<Bandpass>*	with query	6.58
CONFigure:MULTitone:AF1Channel:FILTer:BPASs:DCCoupling	*<Bandpass>*	with query	6.58
CONFigure:MULTitone:AF1Channel:FILTer:WEIGhting	*<Weighting>*	with query	6.59
DISPlay:MULTitone:AF1Channel:GRID	ON | OFF	with query	6.50
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:LOWer	*<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20>*	with query	6.54
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:UPPer	*<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20>*	with query	6.53
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:UPPer	*<Limit>, <Enable>*	with query	6.53
DEFault:MULTitone:AF1Channel:LIMit:LINE:DEFault	ON | OFF	with query	6.54
CALCulate[:SCALar]:MULTitone:AF1Channel:MATChing:LIMit?	<Result>	query only	6.61
CALCulate:ARRay:MULTitone:AF1Channel:MATChing:LIMit?	<Result>	query only	6.61
CONFigure:MULTitone:AF1Channel:RLEVel	0.001 V to 5.000 V	with query	6.50
CONFigure:MULTitone:AF1Channel:RMODe	RLEV | TON1 | ... | TON20	with query	6.50
FETCh:MULTitone:AF1Channel:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 1 to 10000 | NONE	query only	6.50
CONFigure:MULTitone:AF1Channel:TDEFinition	*<Freq_1>, <Lev_1>, <Enable_1>, ... <Freq_20>, <Lev_20>, <Enable_20>*	with query	6.55
CONFigure:MULTitone:AF1Channel:TDEFinition:MODE	<Total_Level>	with query	6.56
CONFigure:MULTitone:AF1Channel:TDEFinition:TLEVel	<Total_Level>	with query	6.56
CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr>	<Frequency>, <Deviation>, ON | OFF	with query	6.56
CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE:ASYMmetric:LOWer	*<Limit>, <Enable>*	with query	6.54
CALCulate[:SCALar]:MULTitone:AF1Channel:TONE<nr>:MATChing:LIMit?	<Result>	query only	6.61
READ[:SCALar]:MULTitone:AF1Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.60
FETCh[:SCALar]:MULTitone:AF1Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.60
SAMPle[:SCALar]:MULTitone:AF1Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.60
READ:ARRay:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.60
FETCh:ARRay:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.60
SAMPle:ARRay:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.60
READ:SUBarrays:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.60
FETCh:SUBarrays:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.60
SAMPle:SUBarrays:MULTitone:AF1Channel?	–100.0 dB to +20.0 dB	query only	6.60
INITiate:MULTitone:AF2Channel	–	no query	6.49

Command	Parameters	Remarks	Page
ABORt:MULTitone:AF2Channel	–	no query	6.49
STOP:MULTitone:AF2Channel	–	no query	6.49
CONTinue:MULTitone:AF2Channel	–	no query	6.49
CONFigure:SUBarrays:MULTitone:AF2Channel	ALL | ARITHmetical | MINimum | MAXimum | IVAL,<Range>{,<Range>}	with query	6.52
CONFigure:MULTitone:AF2Channel:AFGLead	0 s to 0.1 s	with query	6.51
CONFigure:MULTitone:AF2Channel:CONTrol:REPetition	CONTinuous | SINGleshot | 1 to 1000, SONerror | NONE, STEP | NONE	with query	6.51
CONFigure:MULTitone:AF2Channel:CONTrol:TDEFinition	ON | OFF	with query	6.57
CONFigure:MULTitone:AF2Channel:EREPorting	SRQ | SOPC | SRSQ | OFF	with query	6.49
DEFault:MULTitone:AF2Channel:FILTer	ON | OFF	with query	6.59
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:ACCoupling	*<Bandpass>*	with query	6.58
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:DCCoupling	*<Bandpass>*	with query	6.58
CONFigure:MULTitone:AF2Channel:FILTer:WEIGhting	*<Weighting>*	with query	6.59
DISPlay:MULTitone:AF2Channel:GRID	ON | OFF	with query	6.50
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:LOWer	*<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20>*	with query	6.54
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:UPPer	*<Limit_1>, <Enable_1>, ... <Limit_20>, <Enable_20>*	with query	6.53
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:UPPer	*<Limit>, <Enable>*	with query	6.53
DEFault:MULTitone:AF2Channel:LIMit:LINE:DEFault	ON | OFF	with query	6.54
CALCulate[:SCALar]:MULTitone:AF2Channel:MATChing:LIMit?	<Result>	query only	6.61
CALCulate:ARRay:MULTitone:AF2Channel:MATChing:LIMit?	<Result>	query only	6.61
CONFigure:MULTitone:AF2Channel:RLEVel	0.001 V to 5.000 V	with query	6.50
CONFigure:MULTitone:AF2Channel:RMODe	RLEV | TON1 | ... | TON20	with query	6.50
FETCh:MULTitone:AF2Channel:STATus?	OFF | RUN | STOP | ERR | STEP | RDY, 1 to 10000 | NONE	query only	6.50
CONFigure:MULTitone:AF2Channel:TDEFinition	*<Freq_1>, <Lev_1>, <Enable_1>, ... <Freq_20>, <Lev_20>, <Enable_20>*	with query	6.55
CONFigure:MULTitone:AF2Channel:TDEFinition:MODE	<Total_Level>	with query	6.56
CONFigure:MULTitone:AF2Channel:TDEFinition:TLEVel	<Total_Level>	with query	6.56
CONFigure:MULTitone:AF2Channel:TDEFinition:TONE<nr>	<Frequency>, <Deviation>, ON | OFF	with query	6.56
CONFigure:MULTitone:AF2Channel:TONE<nr>:LIMit:LINE:ASYMmetric:LOWer	*<Limit>, <Enable>*	with query	6.54
CALCulate[:SCALar]:MULTitone:AF2Channel:TONE<nr>:MATChing:LIMit?	<Result>	query only	6.61
READ[:SCALar]:MULTitone:AF2Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.60
FETCh[:SCALar]:MULTitone:AF2Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.60
SAMPle[:SCALar]:MULTitone:AF2Channel:TONE<nr>?	–100.0 dB to +20.0 dB	query only	6.60
READ:ARRay:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.60
FETCh:ARRay:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.60
SAMPle:ARRay:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.60
READ:SUBarrays:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.60

Command	Parameters	Remarks	Page
FETCh:SUBarrays:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.60
SAMPle:SUBarrays:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.60
CONFigure:MULTitone:CONTrol:TDEFinition	ON | OFF	with query	6.57
DEFault:MULTitone:FILTer	ON | OFF	with query	6.59
DEFault:MULTitone:LIMit:LINE	ON | OFF	with query	6.55

Alphabetical Command Lists

Table 6-5 Alphabetical list of remote-control commands: Base system

Command (Base System, alphabetical)	Page
CONFigure:SYNChronize:FREQuency:REFerence	6.18
CONFigure:SYNChronize:FREQuency:REFerence:MODE	6.18
*SEC	6.13
STATus:OPERation:CMU:ALL	6.9
STATus:OPERation:CMU:CLEar	6.9
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:CONDition?	6.8
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:ENABle	6.9
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:NTRansition	6.8
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:PTRansition	6.8
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>[EVENt]?	6.8
STATus:OPERation:CMU:SUM<nr>:CONDition?	6.7
STATus:OPERation:CMU:SUM<nr>:ENABle	6.8
STATus:OPERation:CMU:SUM<nr>:NTRansition	6.7
STATus:OPERation:CMU:SUM<nr>:PTRansition	6.7
STATus:OPERation:CMU:SUM<nr>[EVENt]?	6.7
STATus:OPERation:CONDition?	6.6
STATus:OPERation:ENABle	6.7
STATus:OPERation:EVENt:SADDress?	6.11
STATus:OPERation:NTRansition	6.6
STATus:OPERation:PTRansition	6.6
STATus:OPERation:SYMBolic:ENABle	6.11
STATus:OPERation:SYMBolic[:EVENt]?	6.11
STATus:OPERation[EVENt]?	6.6
STATus:PRESet	6.10
STATus:QUEStionable:CONDition?	6.9
STATus:QUEStionable:ENABle	6.10
STATus:QUEStionable:NTRansition	6.10
STATus:QUEStionable:PTRansition	6.10
STATus:QUEStionable[EVENt]?	6.9
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	6.13
SYSTem:COMMunicate:SERial<1|2>:APPLication	6.13
SYSTem:COMMunicate:SERial<1|2>:TRANsmit:PACE	6.14
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD	6.13
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITs	6.14
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PARity[:TYPE]	6.14
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:STOP	6.14
SYSTem:ERRor?	6.5
SYSTem:MISC:KBEep	6.16
SYSTem:MISC:KEYBoard	6.16
SYSTem:MQUeue[:COMPlete]:ITEM?	6.17
SYSTem:MQUeue[:COMPlete][:LIST]?	6.17
SYSTem:NONVolatile:DISable	6.5
SYSTem:OPTions:INFO?	6.14
SYSTem:OPTions?	6.15
SYSTem:PRESet	6.17
SYSTem:REMote:ADDRess:PRIMary	6.12
SYSTem:REMote:ADDRess:SECondary	6.12
SYSTem:TIMe:DATe	6.16
SYSTem:TIMe:TZONe	6.15
SYSTem:TIMe[:TIMe]	6.15
SYSTem:VERSion?	6.5

Command	Parameters	Remarks	Page
FETCh:SUBarrays:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.60
SAMPle:SUBarrays:MULTitone:AF2Channel?	–100.0 dB to +20.0 dB	query only	6.60
CONFigure:MULTitone:CONTrol:TDEFinition	ON | OFF	with query	6.57
DEFault:MULTitone:FILTer	ON | OFF	with query	6.59
DEFault:MULTitone:LIMit:LINE	ON | OFF	with query	6.55

Alphabetical Command Lists

Table 6-5 Alphabetical list of remote-control commands: Base system

Command (Base System, alphabetical)	**Page**
CONFigure:SYNChronize:FREQuency:REFerence	*6.18*
CONFigure:SYNChronize:FREQuency:REFerence:MODE	*6.18*
**SEC*	*6.13*
STATus:OPERation:CMU:ALL	*6.9*
STATus:OPERation:CMU:CLEar	*6.9*
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:CONDition?	*6.8*
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:ENABle	*6.9*
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:NTRansition	*6.8*
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>:PTRansition	*6.8*
STATus:OPERation:CMU:SUM<nr>:CMU<nr_event>[EVENt]?	*6.8*
STATus:OPERation:CMU:SUM<nr>:CONDition?	*6.7*
STATus:OPERation:CMU:SUM<nr>:ENABle	*6.8*
STATus:OPERation:CMU:SUM<nr>:NTRansition	*6.7*
STATus:OPERation:CMU:SUM<nr>:PTRansition	*6.7*
STATus:OPERation:CMU:SUM<nr>[EVENt]?	*6.7*
STATus:OPERation:CONDition?	*6.6*
STATus:OPERation:ENABle	*6.7*
STATus:OPERation:EVENt:SADDress?	*6.11*
STATus:OPERation:NTRansition	*6.6*
STATus:OPERation:PTRansition	*6.6*
STATus:OPERation:SYMBolic:ENABle	*6.11*
STATus:OPERation:SYMBolic[:EVENt]?	*6.11*
STATus:OPERation[EVENt]?	*6.6*
STATus:PRESet	*6.10*
STATus:QUEStionable:CONDition?	*6.9*
STATus:QUEStionable:ENABle	*6.10*
STATus:QUEStionable:NTRansition	*6.10*
STATus:QUEStionable:PTRansition	*6.10*
STATus:QUEStionable[EVENt]?	*6.9*
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess	*6.13*
SYSTem:COMMunicate:SERial<1|2>:APPLication	*6.13*
SYSTem:COMMunicate:SERial<1|2>:TRANsmit:PACE	*6.14*
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BAUD	*6.13*
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:BITs	*6.14*
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:PARIty[:TYPE]	*6.14*
SYSTem:COMMunicate:SERial<1|2>[:RECeive]:STOP	*6.14*
SYSTem:ERRor?	*6.5*
SYSTem:MISC:KBEep	*6.16*
SYSTem:MISC:KEYBoard	*6.16*
SYSTem:MQUeue[:COMPlete]:ITEM?	*6.17*
SYSTem:MQUeue[:COMPlete][:LIST]?	*6.17*
SYSTem:NONVolatile:DISable	*6.5*
SYSTem:OPTions:INFO?	*6.14*
SYSTem:OPTions?	*6.15*
SYSTem:PRESet	*6.17*
SYSTem:REMote:ADDRess:PRIMary	*6.12*
SYSTem:REMote:ADDRess:SECondary	*6.12*
SYSTem:TIMe:DATe	*6.16*
SYSTem:TIMe:TZONe	*6.15*
SYSTem:TIMe[:TIMe]	*6.15*
SYSTem:VERSion?	*6.5*

Table 6-6 Alphabetical list of remote-control commands: RF

Command (RF, alphabetical)	**Page**
ABORt:POWer	*6.31*
ABORt:RFANalyzer	*6.23*
ABORt:RFGenerator	*6.25*
ABORt:SPECtrum	*6.37*
CONFigure:POWer:CONTrol	*6.32*
CONFigure:POWer:CONTrol:REPetition	*6.32*
CONFigure:POWer:EREPorting	*6.31*
CONFigure:RFANalyzer:CONTrol:REPetition	*6.24*
CONFigure:RFANalyzer:EREPorting	*6.23*
CONFigure:RFANalyzer:POWer:RTIMe	*6.24*
CONFigure:SPECtrum:CONTrol	*6.38*
CONFigure:SPECtrum:CONTrol:REPetition	*6.38*
CONFigure:SPECtrum:EREPorting	*6.37*
CONFigure:SUBarrays:POWer	*6.35*
CONFigure:SUBarrays:SPECtrum	*6.40*
CONTinue:RFANalyzer	*6.23*
DISPlay:POWer:CONTrol:GRID	*6.32*
DISPlay:SPECtrum:CONTrol:GRID	*6.38*
FETCh:ARRAy:SPECtrum[:CURRent]?	*6.41*
FETCh:POWer:STATus?	*6.31*
FETCh:RFANalyzer:STATus?	*6.23*
FETCh:RFGenerator:STATus?	*6.25*
FETCh:SPECtrum:STATus?	*6.37*
FETCh:SUBarrays:POWer:MINimum?	*6.36*
FETCh:SUBarrays:POWer[:CURRent]?	*6.36*
FETCh:SUBarrays:SPECtrum:MINimum?	*6.41*
FETCh:SUBarrays:SPECtrum[:CURRent]?	*6.41*
INITiate:POWer	*6.31*
INITiate:RFANalyzer	*6.23*
INITiate:RFGenerator	*6.25*
INITiate:SPECtrum	*6.37*
INPut[:STATe]	*6.29*
OUTPut[:STATe]	*6.29*
READ:ARRAy:POWer[:CURRent]?	*6.36*
READ:SUBarrays:POWer:MINimum?	*6.36*
READ:SUBarrays:POWer[:CURRent]?	*6.36*
READ:SUBarrays:SPECtrum:MINimum?	*6.41*
READ:SUBarrays:SPECtrum[:CURRent]?	*6.41*
READ[:SCALar]:RFANalyzer:POWer?	*6.24*
SAMPle:ARRAy:SPECtrum[:CURRent]?	*6.41*
SAMPle:SUBarrays:POWer:MINimum?	*6.36*
SAMPle:SUBarrays:POWer[:CURRent]?	*6.36*
SAMPle:SUBarrays:SPECtrum:MINimum?	*6.41*
SAMPle:SUBarrays:SPECtrum[:CURRent]?	*6.41*
SAMPle[:SCALar]:RFANalyzer:POWer?	*6.24*
[SENSe:]CORRection:LOSS:INPut<nr>[:MAGNitude]	*6.29*
[SENSe:]CORRection:LOSS:OUTPut<nr>[:MAGNitude]	*6.30*
[SENSe:]LEVel:ATTenuation	*6.19*
[SENSe:]LEVel:MAXimum	*6.19*
[SENSe:]LEVel:MODE	*6.19*
[SENSe:]LEVel:REFerence	*6.20*
[SENSe:]POWer:FREQuency:BANDwidth[:RESolution]	*6.33*
[SENSe:]POWer:FREQuency:BWIDth[:RESolution]	*6.33*
[SENSe:]POWer:FREQuency:CENTer	*6.33*
[SENSe:]POWer:LEVel:RANGe	*6.33*
[SENSe:]POWer:TIME:DELay	*6.34*

Command (RF, alphabetical)	**Page**
[SENSe:]POWer:TIME:SPAN	*6.34*
[SENSe:]RFANalyzer:BANDwidth[:RESolution]	*6.22*
[SENSe:]RFANalyzer:BWIDth[:RESolution]	*6.22*
[SENSe:]RFANalyzer:FREQuency	*6.22*
[SENSe:]SPECtrum:FREQuency:BANDwidth[:RESolution]	*6.39*
[SENSe:]SPECtrum:FREQuency:BWIDth[:RESolution]	*6.39*
[SENSe:]SPECtrum:FREQuency:CENTer	*6.39*
[SENSe:]SPECtrum:FREQuency:SPAN	*6.39*
[SENSe:]SPECtrum:FREQuency:STARt	*6.39*
[SENSe:]SPECtrum:FREQuency:STOP	*6.39*
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Command (Audio, alphabetical)	**Page**
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ABORt:AFANalyzer[:PRIMary]	*6.43*
ABORt:AFGenerator:SECondary	*6.48*
ABORt:AFGenerator[:PRIMary]	*6.48*
ABORt:MULTitone:AF1Channel	*6.49*
ABORt:MULTitone:AF2Channel	*6.49*
CALCulate:ARRay:MULTitone:AF1Channel:MATChing:LIMit?	*6.61*
CALCulate:ARRay:MULTitone:AF2Channel:MATChing:LIMit?	*6.61*
CALCulate[:SCALar]:MULTitone:AF1Channel:MATChing:LIMit?	*6.61*
CALCulate[:SCALar]:MULTitone:AF1Channel:TONE<nr>:MATChing:LIMit?	*6.61*
CALCulate[:SCALar]:MULTitone:AF2Channel:MATChing:LIMit?	*6.61*
CALCulate[:SCALar]:MULTitone:AF2Channel:TONE<nr>:MATChing:LIMit?	*6.61*
CONFigure:AFANalyzer:SECondary:CONTrol:COUPling	*6.45*
CONFigure:AFANalyzer:SECondary:CONTrol:DISTortion[:FREQuency]	*6.45*
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CONFigure:AFANalyzer:SECondary:FILTer:VBPass:CFRequency 6.46
CONFigure:AFANalyzer:SECondary:FILTer:WEIGhting 6.46
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CONFigure:AFANalyzer[:PRIMary]:CONTrol:DISTortion[:FREQuency] 6.45
CONFigure:AFANalyzer[:PRIMary]:CONTrol:REPetition 6.45
CONFigure:AFANalyzer[:PRIMary]:EREPorting 6.43
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CONFigure:MULTitone:AF1Channel:FILTer:BPASs:ACCoupling 6.58
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CONFigure:MULTitone:AF1Channel:FILTer:WEIGhting 6.59
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:LOWer 6.54
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:UPPer 6.53
CONFigure:MULTitone:AF1Channel:LIMit:LINE:ASYMmetric:UPPer 6.53
CONFigure:MULTitone:AF1Channel:RLEVel 6.50
CONFigure:MULTitone:AF1Channel:RMODe 6.50
CONFigure:MULTitone:AF1Channel:TDEFinition 6.55
CONFigure:MULTitone:AF1Channel:TDEFinition:MODE 6.56
CONFigure:MULTitone:AF1Channel:TDEFinition:TLEVel 6.56
CONFigure:MULTitone:AF1Channel:TDEFinition:TONE<nr> 6.56
CONFigure:MULTitone:AF1Channel:TONE<nr>:LIMit:LINE:ASYMmetric:LOWer 6.54
CONFigure:MULTitone:AF2Channel:AFGLead 6.51
CONFigure:MULTitone:AF2Channel:CONTrol:REPetition 6.51
CONFigure:MULTitone:AF2Channel:CONTrol:TDEFinition 6.57
CONFigure:MULTitone:AF2Channel:EREPorting 6.49
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:ACCoupling 6.58
CONFigure:MULTitone:AF2Channel:FILTer:BPASs:DCCoupling 6.58
CONFigure:MULTitone:AF2Channel:FILTer:WEIGhting 6.59
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:LOWer 6.54
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:UPPer 6.53
CONFigure:MULTitone:AF2Channel:LIMit:LINE:ASYMmetric:UPPer 6.53
CONFigure:MULTitone:AF2Channel:RLEVel 6.50
CONFigure:MULTitone:AF2Channel:RMODe 6.50
CONFigure:MULTitone:AF2Channel:TDEFinition 6.55
CONFigure:MULTitone:AF2Channel:TDEFinition:MODE 6.56
CONFigure:MULTitone:AF2Channel:TDEFinition:TLEVel 6.56
CONFigure:MULTitone:AF2Channel:TDEFinition:TONE<nr> 6.56
CONFigure:MULTitone:AF2Channel:TONE<nr>:LIMit:LINE:ASYMmetric:LOWer 6.54
CONFigure:MULTitone:CONTrol:TDEFinition 6.57
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CONFigure:SUBarrays:MULTitone:AF2Channel 6.52
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CONTinue:AFANalyzer[:PRIMary] 6.43
CONTinue:MULTitone:AF1Channel 6.49
CONTinue:MULTitone:AF2Channel 6.49
DEFault:MULTitone:AF1Channel:FILTer 6.59
DEFault:MULTitone:AF1Channel:LIMit:LINE:DEFault 6.54
DEFault:MULTitone:AF2Channel:FILTer 6.59
DEFault:MULTitone:AF2Channel:LIMit:LINE:DEFault 6.54

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DEFault:MULTitone:FILTer 6.59
DEFault:MULTitone:LIMit:LINE 6.55
DISPlay:MULTitone:AF1Channel:GRID 6.50
DISPlay:MULTitone:AF2Channel:GRID 6.50
FETCh:AFAnalyzer:SECondary:STATus? 6.44
FETCh:AFAnalyzer[:PRIMary]:STATus? 6.44
FETCh:AFGenerator:SECondary:STATus? 6.48
FETCh:AFGenerator[:PRIMary]:STATus? 6.48
FETCh:ARRay:MULTitone:AF1Channel? 6.60
FETCh:ARRay:MULTitone:AF2Channel? 6.60
FETCh:MULTitone:AF1Channel:STATus? 6.50
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FETCh:SUBarrays:MULTitone:AF1Channel? 6.60
FETCh:SUBarrays:MULTitone:AF2Channel? 6.60
FETCh[:SCALar]:AFANalyzer:SECondary? 6.47
FETCh[:SCALar]:AFANalyzer[:PRIMary]? 6.47
FETCh[:SCALar]:MULTitone:AF1Channel:TONE<nr>? 6.60
FETCh[:SCALar]:MULTitone:AF2Channel:TONE<nr>? 6.60
INITiate:AFANalyzer:SECondary 6.43
INITiate:AFANalyzer[:PRIMary] 6.43
INITiate:AFGenerator:SECondary 6.48
INITiate:AFGenerator[:PRIMary] 6.48
INITiate:MULTitone:AF1Channel 6.49
INITiate:MULTitone:AF2Channel 6.49
READ:ARRay:MULTitone:AF1Channel? 6.60
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READ:SUBarrays:MULTitone:AF1Channel? 6.60
READ:SUBarrays:MULTitone:AF2Channel? 6.60
READ[:SCALar]:AFANalyzer:SECondary? 6.47
READ[:SCALar]:AFANalyzer[:PRIMary]? 6.47
READ[:SCALar]:MULTitone:AF1Channel:TONE<nr>? 6.60
READ[:SCALar]:MULTitone:AF2Channel:TONE<nr>? 6.60
SAMPle:ARRay:MULTitone:AF1Channel? 6.60
SAMPle:ARRay:MULTitone:AF2Channel? 6.60
SAMPle:SUBarrays:MULTitone:AF1Channel? 6.60
SAMPle:SUBarrays:MULTitone:AF2Channel? 6.60
SAMPle[:SCALar]:AFANalyzer:SECondary? 6.47
SAMPle[:SCALar]:AFANalyzer[:PRIMary]? 6.47
SAMPle[:SCALar]:MULTitone:AF1Channel:TONE<nr>? 6.60
SAMPle[:SCALar]:MULTitone:AF2Channel:TONE<nr>? 6.60
[SENSe:]AFLevel:DEFault 6.43
[SENSe:]AFLevel:MAXimum 6.42
[SENSe:]AFLevel:MODE 6.42
SOURce:AFGenerator:SECondary:FREQuency 6.48
SOURce:AFGenerator:SECondary:LEVel 6.48
SOURce:AFGenerator[:PRIMary]:FREQuency 6.48
SOURce:AFGenerator[:PRIMary]:LEVel 6.48
STOP:AFANalyzer:SECondary 6.43
STOP:AFANalyzer:SECondary 6.43
STOP:MULTitone:AF1Channel 6.49
STOP:MULTitone:AF2Channel 6.49

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7 Remote Control – Program Examples

The program examples in this chapter are intended to give a short introduction to GPIB bus programming of the CMU illustrating some of the concepts discussed in Chapter 5. For examples involving optional function groups (network tests) refer to the relevant manuals, e.g. *CMU-K21/-K22/-K23*.

Secondary Address Handling

The following example explains how to handle primary and secondary addressing and how to perform a simple measurement with the CMU. In the example, remote control via the *National Instruments* GPIB bus driver (NI-488.2) and the programming language C is used. Once the addresses are assigned, the same commands can be used in different function groups.

```
// Include header files
#include <string.h>

/*  NI488.2 header file */
#include <decl.h>

// GPIB board index
#define BdIndx                      0

// Primary address
#define pad                         20

// Secondary address for Base Definition (National Instruments specific)
#define sad_BASE                    96

// Secondary  Address for function groups definition
// (conforming to IEEE488.2)
#define _RF_NSig                     1
#define _GSM900MS_Sig                2
#define _GSM900MS_NSig               3
#define _GSM1800MS_Sig               4

#define sad_RF_NSig                sad_BASE + _RF_NSig
#define sad_GSM900MS_Sig           sad_BASE + _GSM900MS_Sig
#define sad_GSM900MS_NSig          sad_BASE + _GSM900MS_NSig
#define sad_GSM1800MS_Sig          sad_BASE + _GSM1800MS_Sig

// Timeout
#define tmo                         (int) 10

// EOT
#define eot                         (int) 1

// EOS
#define eos                         (int) 0

// Command definition for secondary address mapping
```

```
#define Map_Command             "SYST:REM:ADDR:SEC %d,\"%s\""

#define IdStr_RF_NSig                "RF_NSig"
#define IdStr_GSM900MS_Sig      "GSM900MS_Sig"
#define IdStr_GSM900MS_NSig     "GSM900MS_NSig"
#define IdStr_GSM1800MS_Sig    "GSM1800MS_Sig "

// Variable declarations
int h_BASE;
int h_RF_NSig;
int h_GSM900MS_Sig;
int h_GSM900MS_NSig;
int h_GSM1800MS_Sig;

char InBuffer [100];
char Command [100];

// Request of the basesystem handle
h_BASE = ibdev (BdIndx, pad, sad_BASE, tmo, eot, eos);

// Mapping of secondary addresses for the function groups
sprintf (Command, Map_Command, _RF_NSig,IdStr_RF_NSig);
ibwrt(h_BASE, Command, strlen(Command));
sprintf (Command, Map_Command, _GSM900MS_Sig, IdStr_GSM900MS_Sig);
ibwrt(h_BASE,Command, strlen(Command));
sprintf (Command, "Map_Command _GSM900MS_NSig, IdStr_GSM900MS_NSig);
ibwrt(h_BASE,Command, strlen(Command));
sprintf (Command, "Map_Command _GSM1800MS_Sig, IdStr_GSM1800MS_Sig);
ibwrt(h_BASE,Command, strlen(Command));

// Request of function group handles
h_RF_NSig = ibdev (BdIndx, pad, sad_RF_NSig, tmo, eot, eos);
h_GSM900MS_Sig = ibdev (BdIndx, pad, sad_GSM900MS_Sig, tmo, eot, eos);
h_GSM900MS_NSig = ibdev (BdIndx, pad, sad_GSM900MS_NSig, tmo, eot, eos);
h_GSM1800MS_Sig = ibdev (BdIndx, pad, sad_GSM1800MS_Sig, tmo, eot, eos);
```

Simple Measurements

The following measurement examples require option CMU-K21/-K22/-K23 to be installed – see separate operating manual for GSM900/1800/1900 mobile tests.

```
// Example for a GSM900 mobile with power and
// modulation measurement at PCL 5 and PCL 10


ibwrt(h_GSM900MS_Sig, "PROC:SIGN:MS:PCL 5", 18);
ibwrt(h_GSM900MS_Sig, "READ:SCAL:POW:RES?", 18);
ibrd (h_GSM900MS_Sig, InBuffer, sizeof (InBuffer));
...
ibwrt(h_GSM900MS_Sig, "READ:SCAL:MOD:RES?",18);
ibrd (h_GSM900MS_Sig, InBuffer, sizeof (InBuffer));
...
ibwrt(h_GSM900MS_Sig, "PROC:SIGN:MS:PCL 10",19);
ibwrt(h_GSM900MS_Sig, "READ:SCAL:POW:RES?",18);
ibrd (h_GSM900MS_Sig, InBuffer,sizeof (InBuffer));
...
ibwrt(h_GSM900MS_Sig, "READ:SCAL:MOD:RES?",18);
ibrd (h_GSM900MS_Sig, InBuffer,sizeof (InBuffer));
...

// Example for a GSM1800 mobile with a power and
// modulation measurement at PCL 5 and PCL 10


ibwrt(h_GSM1800MS_Sig, "PROC:SIGN:MS:PCL 5",18);
ibwrt(h_GSM1800MS_Sig, "READ:SCAL:POW:RES?",18);
ibrd (h_GSM1800MS_Sig, InBuffer,sizeof (InBuffer));
...
ibwrt(h_GSM1800MS_Sig, "READ:SCAL:MOD:RES?",18);
ibrd (h_GSM1800MS_Sig, InBuffer,sizeof (InBuffer));
...
ibwrt(h_GSM1800MS_Sig, "PROC:SIGN:MS:PCL 10",19);
ibwrt(h_GSM1800MS_Sig, "READ:SCAL:POW:RES?",18);
ibrd (h_GSM1800MS_Sig, InBuffer,sizeof (InBuffer));
...
ibwrt(h_GSM1800MS_Sig, "READ:SCAL:MOD:RES?",18);
ibrd (h_GSM1800MS_Sig, InBuffer,sizeof (InBuffer));
```

Measuring the I/Q Spectrum of a Mobile

GSM uses the GMSK modulation scheme with a symbol rate of 270.833 kBit/s and four different phases that can be occupied during one symbol interval. If a constant series of zeros or ones is transmitted, the rotation of the I/Q vector causes a side band at 270.833/4 Hz = 667.70825 Hz from the carrier. Compared to the side band, the original carrier frequency is suppressed by –30 dB to –40 dB. The following example program measures the carrier signal, the upper and the lower side band using the *RF Spectrum* and the *RF Power vs Time* measurement groups. No additional options are needed.

To keep the syntax as short and simple as possible, the programs were written with the aid of *Winbatch*, a batch job tool organizing and simplifying the transfer of commands and data between the controller and the instrument.

Winbatch uses device names such as *CMUBASE, CMUGSMNS, CMUGSMSIG* which are previously defined and assigned to the primary address, secondary address, and some general device settings. With these device names, a complete command line reads:

```
CMUBASE: <CMU_Command>
```

where `<CMU_Command>` may be any of the commands (setting commands or queries) specified within the function group and mode identified by the device name *CMUBASE.* Program sequences consisting of commands that are defined in several function groups and modes can be re-used with an exchanged device name.

In addition to these data transfer commands, *Winbatch* provides *WHILE, GOTO*, and *IF* statements to express conditions and define loops. Program examples utilizing these statements can be found in the manuals for network tests, e.g. *GSM900/1800/1900-MS*. For the following example, configure your *Winbatch* settings such that *CMUBASE* is the device name for the CMU *BASE* system and *CMURF* denotes function group *RF (Non Signalling).*

```
ECHO ON

FPRINT ..........................................................................
FPRINT    INITIALISATION ROUTINE:
FPRINT    ASK FOR THE IDENTIFIER OF THE CMU, RESET THE INSTRUMENT,
FPRINT    DEFINE THE SECONDARY ADDRESSES FOR ALL AVAILABLE FUNCTION GROUPS
FPRINT ..........................................................................

CMUBASE: *IDN?                          Identification query
CMUBASE: *RST;*OPC?                     Reset the instrument; prevent the following command
                                            to be executed before *RST is complete
CMUBASE: *CLS                           Clear output buffer, set status byte
CMUBASE: SYST:REM:ADDR:SEC 1,"RF_NSig"  Define function group RF Non Signalling; the CMU Base
                                            system is always assigned secondary address 0

FPRINT ...........................................................................
FPRINT   CONNECTORS
FPRINT ...........................................................................

CMURF: INP:STAT RF2                     Define input connector RF2
CMURF: OUTP:STAT RF2                    Define output connector RF2

FPRINT ...........................................................................
FPRINT   RF GENERATOR SETTINGS
FPRINT ...........................................................................

CMURF: SOUR:RFG:FREQ 900 MHZ            Set RF generator frequency
CMURF: SOUR:RFG:MOD SSB                 Switch on frequency offset (single side band modulation)
CMURF: SOUR:RFG:MOD:SSB:FREQ 67.7 KHZ   Set offset frequency
CMURF: INIT:RFG;*OPC?                   Switch on RF generator


FPRINT ...........................................................................
FPRINT   SPECTRUM ANALYZER SETTINGS
FPRINT   REFERENCE LEVEL ONLY EXISTS IN THE MANUAL MODE (Defines display area)
FPRINT ...........................................................................

CMURF: SENS:SPEC:FREQ:CENT 900 MHZ      Set center frequency for spectrum measurement
CMURF: SENS:SPEC:FREQ:SPAN 500 KHZ      Set frequency span
CMURF: SENS:SPEC:FREQ:BAND 20 KHZ       Set resolution bandwidth of the spectrum analyzer
CMURF: CONF:SPEC:CONT:REP SING,NONE,NONE Single shot measurement, no stop on error

FPRINT ...........................................................................
FPRINT   SPECTRUM MEASUREMENT AT 900 MHZ + OFFSET 67.7 KHZ, 1 POINT
FPRINT ...........................................................................

CMURF: CONF:ARR:SPEC:RANG 900.0677 MHZ,1 Select single measurement point at 900.0677 MHz
CMURF: READ:ARR:SPEC?                   Start single shot spectrum measurement, wait until it is
                                            terminated, and return result (1 value)

FPRINT ...........................................................................
FPRINT   HAVE A LOOK AT SPECIFIC OFFSETS (SUPPRESSED CARRIER AT 900 MHZ)
FPRINT ...........................................................................

CMURF: CONF:ARR:SPEC:RANG 900 MHZ,1     Select single measurement point
CMURF: READ:ARR:SPEC?                   Start single shot spectrum measurement, wait until it is
                                            terminated, and return result (1 value)

FPRINT ...........................................................................
FPRINT   HAVE A LOOK AT SPECIFIC OFFSETS (THE OTHER SIDEBAND 900 MHZ - 67.7 KHZ)
FPRINT ...........................................................................

CMURF: CONF:ARR:SPEC:RANG 899.9323 MHZ,1 Select single measurement point
CMURF: READ:ARR:SPEC?                   Start single shot spectrum measurement, wait until it is
                                            terminated, and return result (1 value)

FPRINT ...........................................................................
```

```
CMURF: ABOR:SPEC                           Abort spectrum measurement and free resources

FPRINT ..............................................................................
FPRINT   PRODUCE A RAMPED SIGNAL
FPRINT ..............................................................................

CMURF: SOUR:RFG:PULS:STAT ON;*OPC?         Select pulsed signal (as opposed to CW)

FPRINT ..............................................................................
FPRINT   CONFIGURE THE POWER/T MEASUREMENT
FPRINT ..............................................................................

CMURF: SENS:POW:FREQ:CENT 900.0677 MHZ     Set center frequency for power vs. time measurement
CMURF: SENS:POW:FREQ:BAND 20 KHZ           Set resolution bandwidth of the RF analyzer
CMURF: SENS:POW:TIME:SPAN 1MS              Set evaluation time of power measurement
CMURF: TRIG:SOUR IFP                       Trigger meas. by IF signal level (recommended)
CMURF: LEV:MAX -10                         Set expected maximum input level

CMURF: CONF:ARR:POW:RANG 3E-4,1            Select single measurement point at 0.3 ms
CMURF: CONF:POW:CONT:REP SING,NONE,NONE    Single shot measurement, no stop on error
CMURF: SYST:ERR?                           Read error queue
CMURF: INIT:POW                            Initiate power vs. time measurement

CMURF: READ:ARR:POW?                       Start single shot measurement, wait until it is
                                               terminated, and return result (1 value)

FPRINT ..............................................................................
FPRINT   HAVE A LOOK AT SPECIFIC OFFSETS (SUPPRESSED CARRIER AT 900 MHZ)
FPRINT ..............................................................................

CMURF: SENS:POW:FREQ:CENT 900 MHZ          Set center frequency for power vs. time measurement
CMURF: READ:ARR:POW?                       Start single shot measurement, wait until it is
                                               terminated, and return result (1 value)

FPRINT ..............................................................................
FPRINT   HAVE A LOOK AT SPECIFIC OFFSETS (THE OTHER SIDEBAND 900 MHZ - 67.7 KHZ)
FPRINT ..............................................................................

CMURF: SENS:POW:FREQ:CENT 899.9323 MHZ     Set center frequency for power vs. time measurement
CMURF: READ:ARR:POW?                       Start single shot measurement, wait until it is
                                               terminated, and return result (1 value)

SETLOCAL                                   Quit remote control mode
```

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8 Maintenance and Interfaces

The following chapter contains information on the maintenance of the CMU.

Please follow the instructions in the service manual when exchanging modules or ordering spares. The order no. for spare parts can be found in the service manual.

The address of our support center and a list of all Rohde & Schwarz service centers can be found at the beginning of this manual.

The service manual includes further information particularly on troubleshooting, repair, exchange of modules (including battery exchange, adjustment of the OCXO oscillator) and calibration.

Maintenance

The CMU does not require any special maintenance. Remove any contamination on the instrument by means of a soft cloth. Make sure that the air vents are not obstructed.

Cleaning the Outside

The outside of the instrument is suitably cleaned using a soft, line-free dust cloth.

Caution!
Never use solvents such as thinners, acetone and similar things, as they may damage the front panel labeling or plastic parts.

Storing and Packing

The CMU can be stored at the temperature range quoted in the data sheet. When stored for an extended period of time the instrument should be protected against dust.

The original packing should be used, particularly the protective covers at the front and rear, when the instrument is to be transported or dispatched. If the original packing is no longer available, use a sturdy cardboard box of suitable size and carefully wrap the instrument to protect it against mechanical damage.

Hardware Interfaces

GPIB Bus Interface

The standard instrument is equipped with an GPIB bus (IEC/IEEE-bus) connection. The interface connector labeled *IEEE 488 / IEC 625* is located on the rear panel of the instrument. A controller for remote control can be connected via the GPIB bus interface using a shielded cable.

Characteristics of the Interface

- 8-bit parallel data transfer,
- bidirectional data transfer,
- three-line handshake,
- high data transfer rate of max. 350 kByte/s,
- up to 15 devices can be connected,
- maximal length of the connecting cables 15 m (single connection 2 m),
- wired OR if several instruments are connected in parallel.

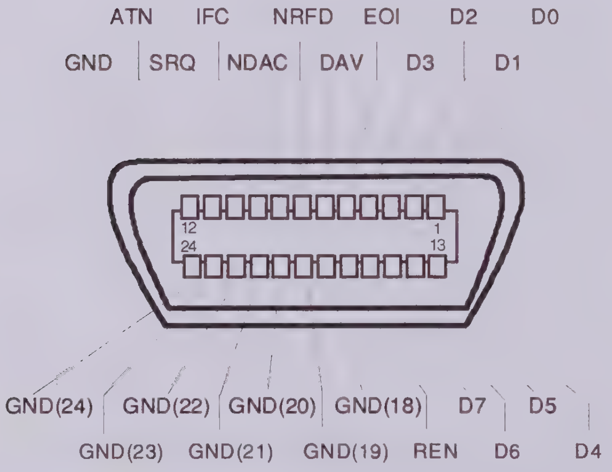

ATN
IFC
NRFD
EOI
D2
D0
GND
SRQ
NDAC
DAV
D3
D1
12
1
24
13
GND(24)
GND(22)
GND(20)
GND(18)
D7
D5
GND(23)
GND(21)
GND(19)
REN
D6
D4

Fig. 8-1 Pin Assigment of the GPIB bus interface

Bus Lines

1. Data bus with 8 lines D0 to D7

The transmission is bit-parallel and byte-serial in the ASCII/ISO code. D0 is the least significant bit, D7 the most significant bit.

2. Control bus with 5 lines

IFC (Interface Clear),
active LOW resets the interfaces of the instruments connected to the default setting.

ATN (Attention),
active LOW signals the transmission of interface messages
inactive HIGH signals the transmission of device messages.

SRQ (Service Request),
active LOW enables the connected device to send a service request to the controller.

REN (Remote Enable),
active LOW permits switchover to remote control.

EOI (End or Identify),
has two functions in connection with ATN:

ATN=HIGH	active LOW marks the end of data transmission.
ATN=LOW	active LOW triggers a parallel poll.

3. Handshake bus with three lines

DAV (Data Valid),
active LOW signals a valid data byte on the data bus.

NRFD (Not Ready For Data),
active LOW signals that one of the connected devices is not ready for data transfer.

NDAC (Not Data Accepted),
active LOW signals that the instrument connected is accepting the data on the data bus.

Interface Messages

Interface messages are transmitted to the instrument on the data lines, with the attention line being active (LOW). They serve to communicate between controller and instrument.

Universal Commands

Universal commands are encoded in the range 10 through 1F hex. They are effective for all instruments connected to the bus without pervious addressing.

Table 8-1 Universal Commands

Command	**QuickBASIC command**	**Effect on the instrument**
DCL (Device Clear)	IBCMD (controller%, CHR$(20))	Aborts processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
IFC (Interface Clear)	IBSIC (controller%)	Resets the interfaces to the default setting.

Addressed Commands

Addressed commands are encoded in the range 00 through 0F hex. They are only effective for instruments addressed as listeners.

Table 8-2 Addressed Commands

Command	**QuickBASIC command**	**Effect on the instrument**
GTL (Go to Local)	IBLOC (device%)	Transition to the "Local" state (manual control).

Note: *The CMU can not be configured as a high-speed HS488 listener; the commands CFE (Configure Enable) and CFGn (Configure) are not supported.*

Serial Interfaces (COM 1, COM 2)

The CMU is equipped with two serial RS-232-C interfaces. The two assigned 9-pin standard Sub-D male connectors are designated with COM 1 and COM 2 and located on the rear panel. A controller can be connected via this interface for remote control.

The two RS-232 interfaces provide two independent channels which can be active simultaneously. However, setting commands and queries act on the same device hardware. The interfaces are activated and configured in the *Setup - Remote* menu or via remote control using the commands `SYSTem:COMMunicate...`

Interface characteristics

- Serial data transmission in asynchronous mode,
- Bidirectional data transmission via two separate lines,
- Transmission rate selectable from 300 to 19200 baud,
- Logic 0 signal from +3 V to +15 V,
- Logic 1 signal from -15 V to -3 V,
- An external instrument (controller) can be connected,
- Hardware handshake RTS/CTS or software handshake XON/XOFF can be selected.

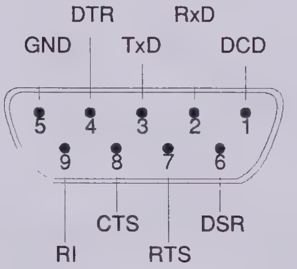


Fig. 8-2 Pin assignment of the RS-232-C interface

Designation	**Abbreviation**	**Pin (9-pin male)**	**Pin (25-pin male)**
Data Carrier Detect	DCD	1	8
Receive Data	RxD	2	3
Transmit Data	TxD	3	2
Data Terminal Ready	DTR	4	20
Signal Ground	GND	5	7
Data Set Ready	DSR	6	6
Request To Send	RTS	7	4
Clear To Send	CTS	8	5
Ring Indicator	RI	9	22

Signal lines

1. Data lines

RxD (Receive Data)
Input data.

Data transfer is bit-serial in the ASCII code, starting with the least significant bit (LSB).

TxD (Transmit Data)
Output data.

Data transfer is bit-serial in the ASCII code, starting with the least significant bit (LSB). The two data lines RxD and TxD are a minimum requirement for data transfer. The following control lines are necessary in addition if a hardware handshake is to be used.

2. Control and message lines

DCD (Data Carrier Detect)
active LOW.
Input; using this signal the data terminal recognizes that the modem of the remote station receives valid data with a sufficient signal level. DCD is used to disable the receiver in the data terminal and prevent reading of false data if the modem cannot interpret the signals of the remote station.

DTR (Data Terminal Ready)
active LOW,
Output; with DTR, the instrument indicates that it is ready to receive data.

DSR (Data Set Ready)
active LOW,
Input; DSR indicates to the instrument that the remote station is ready to receive data.

RTS (Request To Send)
active LOW.
Output; with RTS, the instrument indicates that it is ready to receive data. The RTS line controls whether the instrument is ready to receive data or not.

CTS (Clear To Send)
active LOW.
Input; CTS tells the instrument that the remote station is ready to receive data.

RI (Ring Indicator)
active LOW.
Input; RI is used by a modem to indicate that a remote station wants to set up a connection.

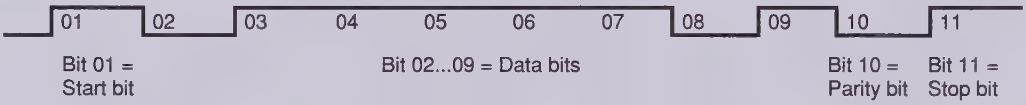
Transmission Parameters

In order to ensure error-free and correct data transmission, the parameters of the instrument and the controller must be set identically. The parameters of the RS-232 interface can be set via the *Setup - Remote* menu or the command group `SYSTem:COMMunicate...`

Table 8-3 Transmission parameters of the RS-232 interface

Parameter	Default	Description / Parameter Range
Baud rate	19200 Baud	The instrument allows baud rates between 110 and 19200 baud to be set, see chapter 4, *Setup - Remote* menu.
Data bits	8	Data transmission is in the 7- or 8-bit ASCII code, starting with the least significant bit (LSB).
Start bit	1	Each data byte begins with a start bit. The falling edge of the start bit indicates the beginning of the data byte.
Parity bit	None	A parity bit can be transmitted for error protection. The settings *No parity*, *even* or *odd* parity are allowed.
Stop bit	1	Transmission of a data byte is terminated by one or two stop bits. The sum of data bits and stop bits must be equal to 9.

Example: Transmission of character 'A' (41 Hex) in 8-bit ASCII code with even parity and one stop bit:



Interface functions

For interface control, some control characters from the ASCII code range of 0 to 20 hex are predefined and can be transmitted via the interface.

Table 8-4 Control strings or control characters of the RS-232-C interface

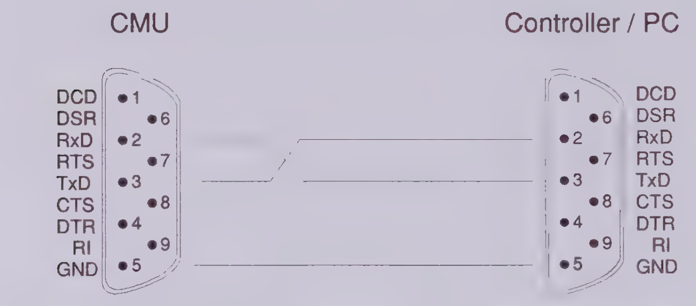
Control Character	Function
Break (at least 1 character only log 0)	Reset instrument
0Dhex, 0Ahex	Terminator <CR>, <LF> Switchover between local/remote

Handshake

Software handshake

In case of a software handshake data transfer is controlled using the two control characters XON / XOFF:

- The CMU uses the control character XON to indicate that it is ready to receive data.
- If the receive buffer is full it sends the XOFF character via the interface to the controller. The controller interrupts data output until it receives another XON from the CMU.
- In the same way the controller indicates to the CMU that it is ready to receive data.

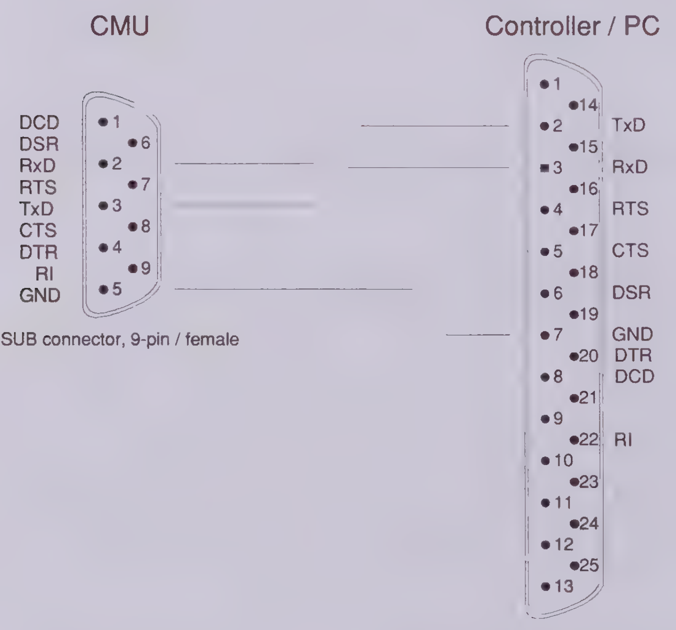

CMU
Controller / PC
DCD
DSR
RxD
RTS
TxD
CTS
DTR
RI
GND
1
6
2
7
3
8
4
9
5
DCD
DSR
RxD
RTS
TxD
CTS
DTR
RI
GND

DSUB connector, 9-pin / female

DSUB connector, 9-pin / female

Connection between instrument and controller (Null-modem cable)

The connection of the instrument to a controller is made with a so-called null-modem cable. Here, the data, control and signalling lines must be crossed. The wiring diagram on the left applies to a controller with a 9-pin or 25-pin configuration.


CMU
Controller / PC
DCD
DSR
RxD
RTS
TxD
CTS
DTR
RI
GND
1
6
2
7
3
8
4
9
5
1
14
2
15
3
16
4
17
5
18
6
19
7
20
8
21
9
22
10
23
11
24
12
25
13
TxD
RxD
RTS
CTS
DSR
GND
DTR
DCD
RI

DSUB connector, 9-pin / female

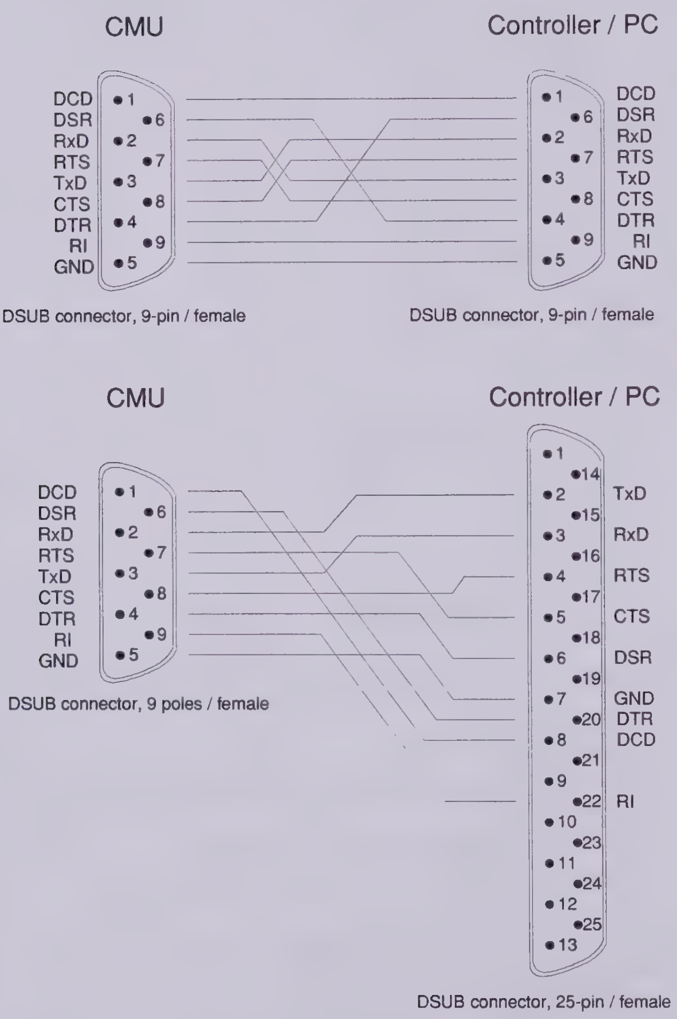
DSUB connector, 25-pin / female

Fig. 8-3 Wiring of the data lines for software handshake

Hardware handshake

In case of a hardware handshake, the instrument signals that it is ready for reception via line DTR and RTS. A logic '0' means "ready" and a '1' means "not ready". The RTS line is always active (logical '0'), provided that the serial interface is switched on. The DTR line controls whether the analyzer is ready for reception or not.

The CTS or DSR lines (see signal lines) tell the instrument whether the remote station is ready for reception or not. A logical '0' on both lines switches on data transmission, a logical '1' on both lines stops data transmission of the generator. The TxD line is used for data transfer.


CMU
Controller / PC
DCD
DSR
RxD
RTS
TxD
CTS
DTR
RI
GND
DSUB connector, 9-pin / female
DSUB connector, 9-pin / female
CMU
Controller / PC
DSUB connector, 9 poles / female
TxD
RxD
RTS
CTS
DSR
GND
DTR
DCD
RI
DSUB connector, 25-pin / female

Connection between instrument and controller (Null-modem cable)

The connection of the instrument to a controller is made with a so-called null-modem cable. Here, the data, control and signalling lines must be crossed. The wiring diagram on the left applies to a controller with a 9-pin or 25-pin configuration.

Fig. 8-4 Wiring of the data, control and message lines for hardware handshake

Connectors for Peripherals

Printer Connector (LPT)

The 25-pin standard Sub-D female connector LPT on the rear panel of the CMU is intended for connecting a printer. The interface is CENTRONICS compatible.

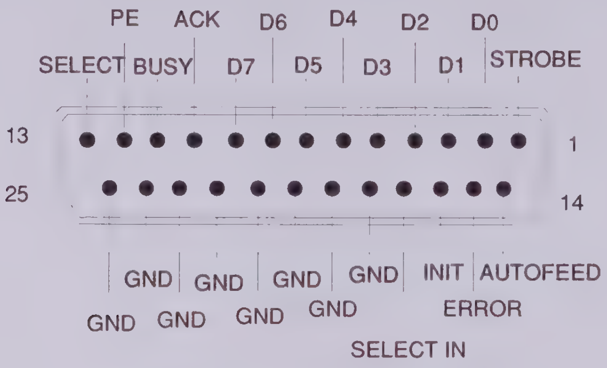
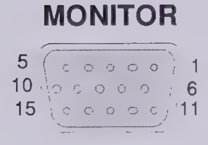


Fig. 8-5 Pin assignment of the LPT connector

Pin	Signal	Input (I) Output (O)	Description
1	STROBE	O	Impulse for transfer of a data byte, 1µs pulse width at minimum (active LOW)
2	D0	O	Data line 0
3	D1	O	Data line 1
4	D2	O	Data line 2
5	D3	O	Data line 3
6	D4	O	Data line 4
7	D5	O	Data line 5
8	D6	O	Data line 6
9	D7	O	Data line 7
10	ACK	I	Indicates that the printer is ready to receive the next byte (active LOW)
11	BUSY	I	Signal active if the printer is unable to receive data
12	PE	I	The signal is activated if no printer paper is available (active HIGH).
13	SELECT	I	The signal is activated when the printer is selected (active HIGH).
14	AUTOFEED	O	If the signal is active the printer inserts a line feed after each line (active LOW).
15	ERROR	I	The signal is activated if no printer paper is available or an error occurred (active LOW).
16	INIT	O	Initializing the printer (active LOW)
17	SELECT IN	O	If the signal is active the codes DC1/DC3 are ignored by the printer (active LOW).
18 - 25	GND		Connected to ground

Monitor Connector (MONITOR)

The 15-pin Sub-D female connector MONITOR at the rear panel of the CMU is intended for connecting an external VGA monitor.

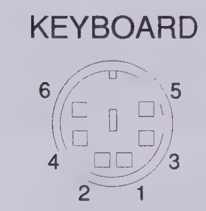


Pin No.	Signal
1	RED (output)
2	GREEN (output)
3	BLUE (output)
4	MID2 (NC)
5	NC
6	R-GND
7	G-GND
8	B-GND
9	NC
10	GND
11	MID0 (NC)
12	MID1 (NC)
13	HSYNC (output)
14	VSYNC (output)
15	NC

Fig. 8-6 Pin assignment of the MONITOR connector

Keyboard Connector (KEYBOARD)

The 6-pole Mini DIN female connector KEYBOARD at the rear of the instrument is intended for connecting an external keyboard. .



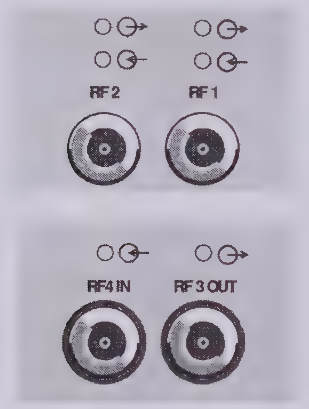
Pin No.	Signal
1	Keyboard data (input)
2	Msdata
3	GND
4	+5 V keyboard power supply (output, max. 0.1 A)
5	Keyboard clock (output)
6	Msclock
Shield	GND

Fig. 8-7 Pin assignment of the KEYBOARD socket

Signal Inputs and Outputs

RF Connectors

The N sockets on the front panel labeled RF1, RF 2, RF 3 OUT and RF4 IN are used as inputs and outputs for RF signals.



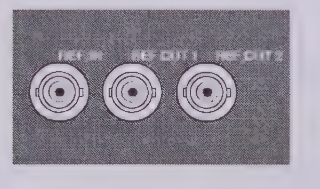
Bidirectional RF connectors

Unidirectional RF connectors

Fig. 8-8 RF connectors

Inputs and Outputs for the Reference Frequency (REF...)

The BNC sockets on the rear panel labeled REF IN, REF OUT 1 and REF OUT2 are used for synchronization of the CMU with external devices.

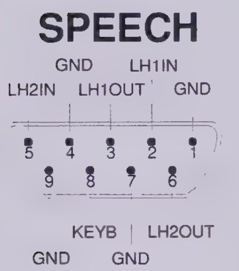


REF IN	This input is used to synchronize the CMU to other instruments. The frequency of the external reference signal fed in at REF IN must be set in the *Sync.* index card of the *Connection Control* menu or via the `CONFigure:SYNChronize:FREQuency:REFerence` command.
REF OUT 1	A signal for synchronization of other instruments is available at this output connector. This signal is either the reference frequency of the CMU or the signal applied to the input REF IN (see *Sync.* index card of the *Connection Control* menu).
REF OUT 2	A clock signal applied to this output and can be used for synchronizing external devices. The clock frequency can be selected from a list of network-specific frequencies in the *Sync.* index card of the *Connection Control* menu.

Fig. 8-9 Inputs and outputs for reference frequency

AF Connector SPEECH (Optional)

The 9-pin Sub-D female connector *SPEECH* on the front panel of the instrument can be used for connecting a handset to the signalling unit.

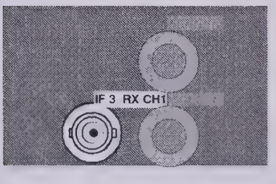

SPEECH
GND
LH1IN
LH2IN
LH1OUT
GND
5
4
3
2
1
9
8
7
6
KEYB
LH2OUT
GND
GND

Pin No.	Signal	Input (I) / Output (O) / Bidirectional (B)	Description
1	GND	B	
2	LH1HAND SETIN	I	AF signals to signalling unit 1
3	LH1HAND SETOUT	O	AF signals from signalling unit 1
4	GND	B	
5	LH2HAND SETIN	I	Signals to signalling unit 2
6	LH2HAND SETOUT	O	Signals from signalling unit 2
7	GND	B	
8	+5VKEYB	O	Power supply +5.2 V, max. 100 mA
9	GND	B	

Fig. 8-10 AF connector SPEECH

IF Signal

One BNC connector providing an IF signal is located on the rear panel of the CMU.



IF3 RX CH1 connector (BNC socket), provides an IF signal from the RXTX board 1 for monitoring purposes.

Fig. 8-11 IF signal output

Service and Auxiliary Connectors

A 9-pin Sub-D female connector *SERVICE* for the modules RXTX Boards is located on the rear panel. This connector is intended for internal tests only and must not be used as a signal input or output.

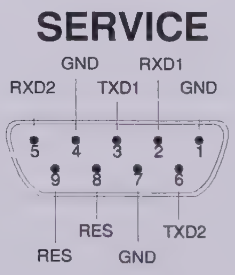
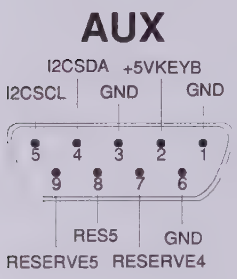

SERVICE
GND
RXD1
RXD2
TXD1
GND
5
4
3
2
1
9
8
7
6
RES
TXD2
RES
GND

Fig. 8-12 SERVICE connector

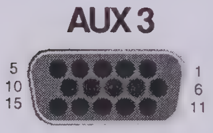
A 9-pin SUB-D female connector AUX on the rear panel provides a +5.2 V supply. The pin assignment is as follows:



Pin	Signal	Input (I) / Output (O) / Bidirectional (B)	Description
1	GND	B	GND
2	+5VKEYB	O	Power supply +5.2 V, max. 100 mA
3	GND	B	GND
4	I2CSDA	B	For future extensions
5	I2CSCL	O	For future extensions
6	GND	B	GND
7	RESERVE4	B	
8	RESERVE5	B	
9	RESERVE6	B	

Fig. 8-13 AUX connector

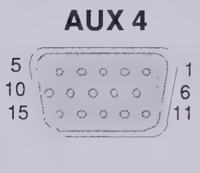
The 15-pin SUB-D female connector AUX 3 on the front panel is used as an input or output for status, control, and trigger signals. These signals are applied to definite pins of the AUX 3 connector (refer to the corresponding menu).
The pin assignment of the AUX 3 connector is as follows:



Pin	Signal	Input (I) / Output (A) / Bidirectional (B)	Description
1	GND	B	
2	TBUS1	O	Timing output A Test signal CH1
3	TBUS2	O	Timing output B
4	TBUS3	O	Timing output C
5	TBUS4	O	Timing output D
6	TBUS5	I	External trigger input CMU300: External trigger signal for wired synchronization
7	TBUS6	I	External trigger B
8	TBUS7	I	External trigger A External trigger signal CH1 input for *Spectrum* and *Power* measurements
9	GND	B	GND
10	GND	B	GND
11	GND	B	GND
12	GND	B	GND
13	GND	B	GND
14	GND	B	GND
15	GND	B	GND

Fig. 8-14 AUX3 connector

The 15-pin SUB-D female connector AUX 4 on the rear panel is used as an input or output for status, control, and trigger signals. These signals are applied to definite pins of the AUX 4 connector (refer to the corresponding menu).
The pin assignment of the AUX 4 connector is as follows:



Pin	Signal	Input (I) / Output / Bidirectional (B)	Description
1	GND	B	GND
2	GND	B	GND
3	GND	B	GND
4	GND	B	GND
5	GND	B	GND
6	GND	B	GND
7	GND	B	GND
8	GND	B	GND
9	TBUS8	B	Status/control/trigger signal
10	TBUS9	B	Status/control/trigger signal
11	TBUS10	B	Status/control/trigger signal
12	TBUS11	B	Status/control/trigger signal
13	TBUS12	B	Status/control/trigger signal
14	TBUS13	B	Status/control/trigger signal
15	TBUS14	B	Status/control/trigger signal

Fig. 8-15 AUX4 connector

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- Operation complete 9.1
- Query error - error upon data request 9.6
- Device-specific error 9.1
- Execution error 9.3
- Command error 9.1

9 Error Messages

SCPI Error Messages

SCPI error messages are the same in all SCPI instruments. The errors are assigned negative numbers. The standard text of the error message is often supplemented by a comment from the CMU which provides more detailed information (device-dependent information). Since this part depends on the individual situation, it often contains more relevant information than the standard text.

No error

Error code	Explanation
0	**No error** This message is output when there are no entries in the error queue.

Command error

The following errors cause bit 5 in the ESR register to be set.

Error code	Explanation
-100	**Command error** Generic error message that cannot detect a more specific error.
-101	**Invalid character** The command contains a character which is invalid for that type.
-102	**Syntax error** The data type received is not accepted at this position.
-103	**Invalid separator** The semicolon was omitted after a program message unit.
-104	**Data type error** The recognized data element is of the wrong type (e.g. character data instead of numeric data)
-105	**GET not allowed** A GET was received within a program message.
-108	**Parameter not allowed** The command contains parameters at a position where they are not accepted.
-109	**Missing parameter** The command does not contain the required parameters.

Error code	Explanation
-111	**Header separator error** A character which is not a legal header separator was encountered while parsing the header; for example, no white space followed the header.
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The sent command header has not been defined.
-114	**Header suffix out of range** The command contains an illegal numeric suffix.
-120	**Numeric data error** An invalid character for the data type being parsed was encountered.
-121	**Invalid character in number** The command contains an illegal numeric suffix.
-123	**Exponent too large** The magnitude of the exponent is too large.
-124	**Too many digits** The decimal numeric data element contains too many digits.
-128	**Numeric data not allowed** The command contains a numeric data element the device does not accept in this position.
-131	**Invalid suffix** The suffix is not appropriate for this command.
-134	**Suffix too long** The suffix contains more than 12 characters.
-138	**Suffix not allowed** A suffix is not allowed for this command or at this point of the command.
-141	**Invalid character data** The character data element contains an invalid character or the element is not valid for this command.
-144	**Character data too long** The character data element contains more than 12 characters.
-148	**Character data not allowed** The character data is prohibited for this command or at this point of the command.
-151	**Invalid string data** A string data element was expected, but was invalid for some reason.

Error code	Explanation
-158	**String data not allowed** The command contains a legal string data element which is not allowed at this point.
-161	**Invalid block data** The command contains illegal block data, e.g. no numeric data element is sent after the introductory #.
-168	**Block data not allowed** The command contains legal block data which are not allowed at this point.
-171	**Invalid expression** The expression data element was invalid; for example, unmatched parentheses or an illegal character.
-178	**Expression data not allowed** A legal expression data was encountered but was not allowed by the device at this point in parsing.
-180	**Macro error** An error occurred when defining a macro or executing a macro.

Execution error

The following errors cause bit 4 in the ESR register to be set.

Error code	Explanation
-200	**Execution error** An execution error as defined in IEEE 488.2, has occurred.
-203	**Command protected**
-211	**Trigger ignored** A triggering signal was received and recognized by the device but was ignored because of timing considerations.
-212	**Arm ignored** An arming signal was received and recognized by the device but was ignored.
-213	**Init ignored** A request for a measurement initiation was ignored as another measurement was already in progress.
-221	**Settings conflict** A setting contradicts another setting. The last attempted setting was not executed.
-222	**Data out of range** A value of the transmitted command was outside the legal range.
-223	**Too much data** More data were sent by the host than the CMU can handle.

Error code	Explanation
-224	**Illegal parameter value** An exact value, from a list of possible values, was expected but not received.
-225	**Out of memory** The CMU software has insufficient memory to perform the requested operation.
-230	**Data corrupt or stale** Possibly invalid data; new reading started but not completed since last access.
-240	**Hardware error** A legal program command or a query could not be executed because of a hardware problem in the device.
-241	**Hardware missing** A legal program command or a query could not be executed because of a missing device hardware.
-250	**Mass storage error** A mass storage error occurred.
-251	**Missing mass storage** A legal program command or a query could not be executed because of missing mass storage.
-252	**Missing media** A legal program command or a query could not be executed because of missing media; for example, no floppy disk.
-253	**Corrupt media** A legal program command or a query could not be executed because of corrupt media; for example, bad floppy disk or wrong format.
-254	**Media full** A legal program command or a query could not be executed because of the media was full; for example, no room on the floppy disk.
-255	**Directory full** The specified directory is full – no more files can be written.
-256	**File name not found** A file with the specified name does not exist.
-257	**File name error** The specified file name cannot be used, e.g. because the file does not exist (reading, clearing) or already exists (writing, generation).
-258	**Media protected** A legal program command or a query could not be executed because the media was protected.

Device-specific error

The following errors cause bit 3 in the ESR register to be set.

Error code	Explanation
-300	**Device-specific error**
-310	**System error** An unspecified system error has occurred.
-311	**Memory error** An error was detected in the device's memory.
-313	**Calibration memory lost** Nonvolatile calibration data have been lost.
-314	**Save/recall memory lost** Nonvolatile saved data have been lost.
-315	**Configuration memory lost** Nonvolatile configuration data saved by the device have been lost.
-330	**Self-test failed** An error occurred during the internal self test.
-350	**Queue overflow** Error code entered in the queue in lieu of the code when the queue is full. It indicates that an error occurred but was not recorded in the queue. The original error message is lost.
-360	**Communication error** An unspecified communication error was detected.
-361	**Parity error in program message** Parity bit was not correct when data were received on a serial port.
-362	**Framing error in program message** No stop bit was detected when data were received on a serial port.
-363	**Input buffer overrun** Software or hardware input buffer on serial port overflows with data caused by improper or nonexistent pacing.

Query error - error upon data request

When the following error codes are output, bit 2 is set in the ESR register.

Error code	Explanation
-400	**Query error**
-410	**Query INTERRUPTED** The query was interrupted. Example: a query is followed by new data before a response was completely sent.
-420	**Query UNTERMINATED** An incomplete query was received. Example: the device is addressed to talk although the received query was incomplete.
-430	**Query DEADLOCKED** A condition causing a DEADLOCKED query error occurred. Example: both input and output buffer are full and the device can not continue.
-440	**Query UNTERMINATED after indefinite response** A query was received in the same program message after a query requesting an indefinite response was execute.

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